AIDE-MÉMOIRE

TO

THE MILITARY SCIENCES.

FRAMED FROM

CONTRIBUTIONS OF OFFICERS

OF

THE DIFFERENT SERVICES,

AND EDITED BY

A COMMITTEE OF THE CORPS OF ROYAL ENGINEERS

1853

VOL I

ABATTIS-----FORD.

WITH NUMEROUS PLATES AND WOOD-CUTS.

Second Edition, corrected.

London:

JOHN WEALE, HIGH HOLBORN.

M DCCC LIII.

HUGHES, PRINTER,
KING'S HEAD COURT, GOUGH SQUARE

PREFACE

TO

THE SECOND EDITION OF THE FIRST VOLUME

OF

THE AIDE-MÉMOIRE

The 'Aide-Mémoire to the Military Sciences' was brought to a conclusion in December, 1851, and a Second Edition of the early Parts having been required, the present Volume—after a careful revision of many of the subjects by their several Contributors—is now submitted to the Officers of the respective Services. A few observations are therefore necessary, for the purpose of explaining any errors or deficiencies which may have occurred in the progress of the Work.

In our first Part we explained that the 'Aide-Mémoire' was intended only as an abstract of principles as well as of details useful to all Branches of Her Majesty's and the East India Company's Forces, although with more especial reference to the wants of our own Corps: hence some of the Collateral Sciences

are given more copiously than usual in Military Works, and if any deficiencies should appear, we must beg our brother Officers to compare the list of subjects proposed in *our Circular of 1843* with the Index at the end of the third volume, and then judge how few there are

The object of the Work, as explained in that Circular, was *to supply, as far as practicable, the* many and common wants of Officers in the Field, in the Colonies and remote Stations, where books of reference are seldom to be found, useful to the Engineer, Artillery, and Line Officers, in their military capacity, as well as to the Governors and Commandants of Posts in their civil capacity, and instructive to all the junior branches of the *Service in their leisure hours*

The 'Aide Mémoire' was not intended to be a Military Dictionary or Encyclopædia, or even a Manual, but as a reminder and reference—for which short Essays and Tables are given—to the Military and Collateral Sciences previously studied The alphabetical arrangement has been followed for convenience, although not implicitly, from *unavoidable difficulties*, and consequently, where there is an apparent omission the Index has in some cases to be consulted

Since the publication commenced, the regulations for admission to the Army have made it indispensably necessary that the Sciences connected with its Duties should be more closely studied, and thus the Work is rendered the more valuable as a Book of Reference to Officers of the Line

The 'Aide Mémoire' will be found to embrace most contingencies required not of an elementary nature, in

Sapping and Mining,

Engineering Duties in the $\left\{\begin{array}{l}\text{Field}\\ \text{Attack and Defence,}\\ \text{Garrison,}\end{array}\right.$

Pontooning and Passages of Rivers,

Principles of the Duties of the $\left\{\begin{array}{l}\text{Cavalry}\\ \text{Artillery}\\ \text{Infantry}\\ \text{Staff}\end{array}\right\}$ Officers,

including the Tactics of the Three Arms, each of which, before the publication of the 'Aide Mémoire,' required a separate work for reference these wants, with the valuable assistance of Officers of the various Services, the Editors have endeavoured to supply

Captain Grivet, of the Corps du Génie, in the Preface to his 'Aide Mémoire,' lately published, explains that he had undertaken the work from the impracticability of inducing Officers to unite their labours for such an object hence Captain Grivet's publication has a want of originality which the 'Aide Mémoire to the Military Sciences' possesses by the united efforts of our Corps and other branches of the Army, and when these have been wanting the Editors have consulted the best authorities to supply those omissions, as will be seen at the end of the third volume in the list of Contributors

Considering the multifarious avocations common to every part of the British Army, and more especially those of the Engineer Corps, the labour has been long and arduous, occupying a period of seven years, much time having been necessarily required to collect

PLATES TO THE FIRST VOLUME.

* Nos. VII VIII. IX. X. and XII. of 'Field Sketching' are double Plates.
† These Plates to be placed opposite page 25 in the second volume.

AIDE-MÉMOIRE.

SKETCH OF THE SCIENCE AND ART OF WAR,

BY LIEUT.-COLONEL C. HAMILTON SMITH.

"Hoc illud est præcipue in cognitione rerum salubre ac frugiferum, omnis exempli documenta in illustri posita monumento intueri; inde tibi tuæque reipublicæ, quod imitere, capias; inde fœdum inceptu, fœdum exitu, quod vites."—T. Livii *Præfatio*

WAR, theoretically studied, is found to depend upon demonstrable principles which make it a science, and the adaptation of the principles to practice converts that science into an art. But, although at first sight the theory is sufficiently clear, the great variety of circumstances which must be taken into consideration, and the momentary alterations these present, are causes that of all arts it is the most complicated and uncertain in the application. Hence, to write on the subject authoritatively would require an intellect capable of fully embracing every branch of the science, as well as practical experience in command. No such claims can be advanced for the following pages, the consideration which they may deserve reposing solely on principles laid down in general by established reputations, such as those of Frederick the Great, Lloyd, Tempelhoff, the Archduke Charles, Jomini, Bulow, Klausewitz, and others, or, as regards the maxims relating to British operations, derived from the above in the form of more particular adaptations, or historically substantiated by events. But, writing less to inculcate than to remind readers familiar with arms, few proofs and short summaries have been preferred to lengthened unnecessary discussions, for which, besides, there was not space in the work. Recourse, however, has been had chiefly to the article 'War,' published in the Supplement of the sixth edition of the 'Encyclopædia Britannica,' and to the 'Precis de l'Art de la Guerre' by General Jomini: the latter may still be regarded as the best on the science, although the author, when adverting to questions where the British army and its commanders are concerned, is generally misinformed, uncandid, and biassed: he evinces a feeling still more bitter against the Prussians, and even against his countryman General Warnery, all the more to be regretted, as this want of impartiality detracts from his authority as a scientific soldier.

It should be observed, moreover, that his maxims, data, and inferential reasoning always emanate from a point of view where armies of 150,000 men or more contend with similar forces on the surface of Europe for the destruction or safety of the greatest empires. These are not ordinary wars, and although the ruling principles must remain the same in all, British forces acting on the Continent, even when they constitute the main strength of an army, still co-operate with allies and with hired auxiliaries, which cause essential modifications in the principles, and the fundamental thought which rules the whole system of its hostility is rarely other than offensively

defensive; directing the blows not to the destruction of the enemy, but to the privation of his colonial and commercial resources, and thus obtaining an honoura peace by the restoration of the balance of power in Europe. In this view the ske here offered is reduced to an abstract form, with a few examples where the questi turn upon great continental operations, in order to afford somewhat more space those which refer directly to insular expeditions, such as constitute the far grea portion of the military operations of the British army. The experience of precedi wars shews that these undertakings are likewise amenable to general principles co pletely in harmony with the general maxims, requiring no other proofs than allusi to past events, most of which are known to all studious Officers, and therefore are no want of circumstantial narratives: yet as they have not been subject to mu public discussion by competent parties, and on some points valid objections ex against received conclusions, cases are pointed out where armies in alliance wi Great Britain might have been saved and positions occupied which would ha arrested the progress of the common enemy, if more enlarged views had sway their resolutions, and more reliance had been placed upon the power that is mistre of the sea. The mere indication of these facts has been deemed sufficient to thos who, understanding war, feel a single word will convey all the other ideas th emanate from them. Where the notices are somewhat more diffuse they relate t such British operations as seem never to have been investigated upon the principle of military science. It is true that assent and dissent to military reasoning depen often not so much upon the absolute truth of the principles as on the manner c considering them in different armies: the geographical position and structure of th Austrian and Prussian territories influence the opinions of their schools as much a those of Russia and France under other conditions produce the same effect, and the British totally different by institutions and insular location, is widely distinct from them all. The value of the aphorisms is therefore narrowed to where they are alike admissible in all, and their importance diminishes as they become more influenced by circumstances.

A British military writer may view the questions involved in the term 'great operations' ('grande tactique' of the French) either as they are based on the general principles of the science, in the light they are viewed by continental strategists, or, narrowing the subject, take it up on the insular position of the empire and the local conditions which result from it. For the one leads to operations of immense armies and objects which menace the very existence of states, while the other contemplates principally defensive measures at home, assistance to an ally abroad, and offensive expeditions to distant countries, mainly depending on the superiority of the Royal Navy, and with land forces in no case amounting to more than 50,000 national troops. Hence, on the continent of Europe, the British land forces seldom form an army, or the majority of an army, though generally they constitute the sinew, or main element of strength in a combined force. The views moreover, which the Government entertain being almost without exception confined to the conquest or recovery of a province in aid of an ally more than for its own aggrandisement,—or, while aiming at the destruction of an enemy's commercial resources, they are directed towards the trading ports or naval stations of an opponent,—the maxims which inculcate striking at the vital power of an enemy through his capital are but little appreciated or applauded. These views are a necessary result of the national military system, for Great Britain, with her immense colonies and popular institutions, on the restoration of peace, always reduces the whole armed establishment to a bare sufficiency for garrisons and recruiting, and on the recurrence of hostility with a great power, such as France, is compelled to reinforce her colonial possessions with nearly the whole of the old and well-

trained regiments, trusting to new levies, and in part to inexperienced subalterns, for the construction of an army for the field. Meantime, the enemy with a great disposable force on land, but inferior at sea, calculates on the restitution or on compensation for the loss of his colonies by assailing a neighbour,—indifferent whether he be an ally of his opponent or a neutral, because the act of invasion will reduce him to be such, possession will give the rights of conquest, and, perhaps, while another continental system is in agitation, full restitution of the lost colonies may be held out as the price of evacuating the unoffending state, and credit demanded for justice and moderation. *But if another great continental power is awakened, and takes up arms,* it must be supplied with subsidies, it meets with discomfiture,—the war is protracted, and at length a corps more or less strong from England joins the ally, and is mainly instrumental in the restoration of affairs, until peace resumes her sway, and bloodshed, debt, and glory is the unsatisfactory reward.

Since the wars of the French revolution, the altered condition of the political preponderance of the great military monarchies and the increased influence of public opinion may be expected to affect the question of hiring foreign troops for British service or taking allies into pay, and the application of steam to maritime war, which will affect more particularly the tranquillity of the coasts, the security of Ireland and of the Channel islands, are novel questions not to be overlooked in cases of future serious hostilities.*

Although some of these are problems solely depending upon the Cabinet for solution, Military Officers who may and ought to be consulted should not be unprepared with opinions duly formed; and from the advanced condition of the science of war on the Continent, together with a consideration of the characters who usually compose foreign ministries, British statesmen cannot themselves remain indifferent to the knowledge of at least the fundamental principles which from henceforth all parties are to look to for security at home and success abroad. For Great Britain and Ireland the defensive question alone requires not simply an accidental or momentary attention directed to a solitary point or instant of alarm, but a well-digested system embracing the whole.

These remarks are submitted as mere instances of the fundamental questions whereon the basis of all military reasoning must repose, but war is a condition of existence so absorbent, so vast, so various and difficult, that viewed as a science it can scarcely be handled but in part, and then it at all becomes so voluminous that we must be contented in this Paper to notice only its more important considerations and give definite notions of terms and their applications to the best of our abilities and the extent our space will allow.

By *Military policy of a state* may be understood the habitual views of a Government regarding its ambition or interests externally directed towards objects to be attained by force, or internally to be guarded by defensive means.

The *Military system of a state* denotes the nature and composition of the forces by sea and land; the militia and reserves; their organization and laws for recruiting, clothing, discipline, instruction, promotion, rewards and punishments; [illegible] fleets, ordnance, equipments and all other elements [illegible] to war.

Military invasion and occupation may occur without [illegible] at the [illegible] connivance of an ally or a neutral power [illegible] the [illegible] of a

* [illegible] these ideas were first written on the article "War" and [illegible] the pamphlet of the Prince de Joinville shews what is the view on the subject in France.

friendly force; or it may be without hostile events, such as a siege or a battle, and thus is not a *positive state of War*.

War is constituted by the actual employment of force, for the purpose of obtaining by arms that which is withheld by similar means: it may be viewed under a variety of modifications.

Thus, war is offensive or defensive; it has for its object the total subversion of the enemy's power, or is confined to reducing it within given bounds. War may be undertaken as a principal, or only as an ally; it then may become one of intervention, or one of opportunity; that is, where a power at first *neutral takes up* the cause of one party, and thereby produces a preponderance with a benefit to all the allies, or to itself in particular, for which it has *been waiting a fit conjunction of* political affairs. In all these cases the mode of enforcing the first great principle of war *requires corresponding* modifications, so as to adapt the means to the end proposed.

There are wars of opinion and religious wars, for which scarcely any rules can be offered, excepting patience, the exercise of humanity, and rectification of real grievances, but these belong not to military *science*, and *do not therefore concern* our present purpose.

War theoretically viewed, should be waged, according to *Jomini*, in conformity [illegible] combinations [illegible] *effect* [illegible] *point*."

This decisive point in war, also termed "*the primitive objective point*," is that wherein resides the *principle* of the hostile strength, or what has been called the vitality of the Government. To dislocate this power in the shortest and most effectual *manner is clearly the fundamental principle* for the assailant, and as *clearly to* avert it by breaking his measures, must be the object of the defendant. But as the *aim of belligerents is commonly of a much less decisive nature, the principle* remains then most applicable, but still the same, to minor objects.

A British expedition necessarily *acts offensively*, the Commander, *fully* instructed in the nature of the operations that are intrusted to him, and familiar with the theatre of war, so far as the best maps, &c., can supply information, has already, in concert with the Government, selected the point intended to form the basis of his operations, which, nevertheless, may greatly vary, from political and nautical, *as well* as considerations of allied co-operation. The choice of a basis always, either on a hostile or a friendly frontier, determines the sphere, or what *is termed the* ZONE OF OPERATIONS: it is from thence the Commander of the Forces selects the objective point which he is to aim at, and the line of operations *leading to it*; and that line may be either temporary or definitive.

Continental armies operate precisely in the same manner, but with more certain facility, because the basis *of their operations* is on their own territory, unopposed by distance, sea, and winds, *for progress or retreat*. Their artillery trains, commissariat, and baggage have their equipments, their cavalry is mounted, and subsistence secure, while a force disembarked from sea is without horses, and always obliged to *sacrifice* invaluable time before it can move, even in a friendly country.

The army marching upon its line of *operations* is in possession of a front of operations, or a strategical *front*, in rear of which it is advisable to fix a point of *appui*, or [illegible]

to oppose its progress, the Commander in Chief either attacks him or manœuvres to compel him to retreat In this view be may select one or two strategical manœuvring lines of a temporary nature, and as such they may deviate to some distance from the intermediate posts, from which they are perfectly distinct To connect the front of operations with the basis, a staple line, &c, will be formed, to subsist parties and convoys at certain places in their daily marches from and to the army, extending it by degrees as the forces proceed further, and more considerable dépôts of provisions will be made on the commissariat lines to subsist the main body If the line of operations deepens in length from its basis, and hostile corps threaten to interrupt it, then there will be the option either of attacking and expelling the enemy's detachments, or of pursuing the main object against the army, without regard to these secondary corps But if it is determined to keep it in check by means of a detachment posted in observation, a double front is produced, and great detachments always cripple the army

When the objective point is neared, and the enemy resolutely maintains his ground, a battle must be the consequence Should the result be indecisive, a second attack must be made, and, when victorious, the ensuing measures should extend beyond the objective point first aimed at, and endeavour to pass beyond it by fixing upon a second ulterior object. If the capture of an important fortress is the aim, while the siege is undertaken, the coercing army should proceed to drive the enemy far off, or, if it be not sufficiently strong after the besieging corps is formed to push forward, a strategical position should be selected to cover the siege, such as the French, under Bonaparte, adopted in 1796 to cover the siege of Mantua, or it should operate as Marlborough did during the siege of Lisle

But where there is no siege, or the army is in force sufficient to carry on operations to a second point, it will become requisite to form a point of *appui*, and to construct an Eventual Basis, by occupying one or more towns sufficiently fortified to be safe from insult, or a small strategical reserve should be formed to cover the rear, to protect convoys and the greater dépôts by means of field works Should rivers of considerable breadth intervene, *têtes de pont* should be raised to cover them, and if the bridges occur at walled towns, some additional works should be constructed to protect them These are requisite both to strengthen these posts and add to the solidity of the Eventual Basis where the strategical reserve may be posted

But should a battle be lost, retreat must ensue towards the basis of operations in order to collect reinforcements and detachments replace the deficient materials and reorganize the elements of combat in fortified towns or intrenched camps so as to arrest the enemy's progress or compel him to divide his forces

When winter approaches, the army is placed in cantonments unless the operations are continued by one of the opposing armies, namely that which having obtained a decided superiority, finds no insuperable obstacles on the hostile line of defence, and is therefore resolved to make the most of its ascendancy then a winter campaign is produced, always equally distressing to both armies, but demanding no particular dispositions excepting redoubled activity in the enterprises, in order to arrive the sooner at the desired results

Such is an abstract view of War as a Theory, and is sufficient to shew the different combinations which the operations produce They are divisible into three branches

I STRATEGICS a term to which it has been vainly endeavoured to affix a strict definition from the times of Folard, Derelinque in MSS,* Bulow, and Von Gross,

* Derelinque Tact que des Batailles de l Impuls on * &c Manuscr pt four vols folio with an immense number of plans in my possess on —C H S

act offensively on a foreign coast the Eastern, from Yarmouth to the Downs the Central, from the Downs and Portsmouth to Southampton and the right or Western, from Southampton to Plymouth and Cork There are, however, many difficulties in the application of masses upon the secondary base abroad, especially if that base must be obtained by force on an hostile coast, because the line of communication from the sea ports at the fixed base whence the army has departed to the point of debarcation is lengthened, and, by reason of the intervention of the elements liable to be broken still the examples of the landing at Aboukir Bay, Copenhagen, the Mondego in Portugal, the Helder and Walcheren, all in the face of the enemy, prove the practicability even when opposed on the spot The point of debarcation is then the Eventual Basis, and unless a friendly fortress, or one that can be compelled to submit by summary means, or a naturally advantageous position can be occupied or immediately forced, the difficulties are almost insurmountable It is again, difficult to despatch a large force in one fleet, and to keep it together, and dangerous to allow great intervals, the elements affect the time, connection and order of convoys an independent and separate service (the navy) influences the primary organization a distinct etiquette may intervene in the moment of execution debarcation, not so much of the troops, as of their resources, artillery, horses provisions, &c, require much of invaluable time, and a change of wind may defeat or endanger the whole measure While a great Captain is at the head of the Army and of the Cabinet, only that which human prudence cannot control will be left to chance, but there have been periods when military experience was not sufficiently appreciated in war measures, and civilians directed them without being even aware that war is an exceedingly complicated science, and that one great error in the plan of operations is sure to end in failure Yet more than two centuries ago Sir Walter Raleigh said, "the wisdom of princes and of states is best determined in their enterprises"

From the difficulties above stated, a practice has arisen of fitting out expeditions, not sufficiently formidable, with a view of ascertaining the practicability of a measure, but which by that very system is often rendered abortive, for a first landing having been effected the enemy's attention is no longer divided, he collects his means of defence, while the second convoy is expected, and the delay is decisive of the event Yet, if in any military operation the effect of masses simultaneously employed be of consequence, it is in those which commence on the sea shore, for the troops have not only to debark and act offensively, but also to construct their means of security and retreat in case of disaster If we examine the primary operations of this class from the wars of King William to the present period, we shall find, that, with the exception of such as were favoured by circumstances, the success or failure was dependent upon one or more of the following maxims, especially as applied to continental expeditions

1 When an army is embarked to make a descent upon an enemy's coast with the object of penetrating into the country, a point of debarcation should be selected where the enemy possesses no local means of arresting the descent and preventing the landing of a sufficient supply of those means which are indispensable for action and for progress If therefore a defensible peninsula can be selected, or better a fortified town accessible for the cannon of the covering squadron, to compel it into an immediate submission, a footing will be gained to form the first point of the Eventual Basis of operations Still the consideration whether such a point is favourable to the ulterior objects of the expedition should be kept in view A secure anchorage is necessary for some time either on the spot or in the immediate vicinity, and within the sphere of action of the land force

2 If the expedition be intended to operate only on the coast with momentary objects, proximity to the objective point should be combined with a locality convenient for re embarcation Armed steamers and gun boats will, in general, secure this object within estuaries, in defiance of a superior enemy on shore But small expeditions are fit only to distract the enemy's attention, and for that object demonstrations without landing will generally answer all the purposes of descents Raleigh justly says, "*All petty attempts are more profitable to the invaded than the invader*"

3 An expedition intended to operate ulteriorly, should be from the first *superior to the probable immediate force of the enemy, so that the landing be* effected with more decisive success, and the ulterior movements may proceed without delay

4 No combinations of invasion should be made to depend on the co-operation of corps expected from distant or opposite quarters It is important to embark them en masse, or, commencing at the more distant part, collect them in passing or form a rendezvous at an intermediate point, so as to proceed at last with the whole in connection For instance, if the season is favourable, a rendezvous off Cork, Bantry Bay, or some island in the Bay of Biscay, when the expedition is really intended for the north or west coast of Spain or Gibraltar, or for the Mediterranean, would tend to keep the enemy in suspense

5 After the landing is securely effected with the view of striking a blow in the interior, it is best to waste no time in besieging any place not directly in the line of operations let them be masked by a corps on shore, and blockaded by *the fleet, or if the line-of battle ships can attack a front of defence, they will* reduce the fortress in a few hours

6 In the plan of an expedition no combination should be admitted including or depending upon two or more lines of operation from separate bases Armies transported by sea are, from that circumstance, not numerous division renders them still weaker, and if one corps is checked the other must retreat also It is exposing two exterior lines to one internal line

7 In colonial and insular expeditions it is only necessary to combine means in proportion to the strength of the objective point, and with attention to the season, climate, monsoon or trade winds

8 An army withdrawing from a territory through another which it is resolved should be kept in subjection or mastered, the occupation should take place at the moment when the greatest mass of forces is passing through or near the most important points

9 When negociating at the head of an armed force with the chance of resistance, it is important that all the corps be collected to give weight to the demands, and to act instantly when hostilities become inevitable, rather than call for reinforcements when they are begun, and risk to be defeated from absolute inferiority

10 In offensive extra European wars it is particularly false economy to employ insufficient means against an enemy, to undervalue his resistance, or to aim at indecisive objects. If such measures cause no absolute failure, they at least prolong the contest, occasion the waste of life and expense, are a source of greater risk than should be incurred, and of less advantage in negociation.*

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* The Saxon Colonel Von Cross (Kriegs Geschichte der Jahre 1792 bis 1805 enumerates on the subject of our marine expeditions several others to be requisite such as —1 Seasonable period; 2 Thorough knowledge of the country 3 Intelligence in the country, 4. Dominion of the sea

None of these rules should be so modified as to be opposed to the great maxims of war; nor should operations of any kind be undertaken without regard to the class of troops to be employed.

As examples of the importance of the first rule, may be quoted the landing of the emigrants at Quiberon; for if they had not been betrayed by their own men, they still, through supineness, were blocked in and unable to debouche in the face of the enemy. Again, the Helder expedition in 1799, though victorious in two battles, could not advance to the objective point, because through former misdirection of the forces, the enemy, retiring to the narrows of the Haerlemmer Meer, had a position which could not be forced nor turned. On the other hand, at Aboukir in Egypt, a peninsula, the landing was on a central point, which placed the enemy's defensive measures on two external lines, one covering Alexandria and the other Rosetta and Cairo; thus divided, although numerically the strongest, he was inferior on both lines, and ultimately forced to surrender. The landing at the point of Mondego, in Portugal, though again divided by a subsequent force coming on shore at Peniche, shewed a still more advantageous selection, for the enemy could not oppose it, nor attack Sir Arthur Wellesley, until all his troops and cannon were already moving offensively the debarcation cut off the north of Portugal from Lisbon, and the hostile army from its line of communication with France, and if the reinforcement under Sir John Moore, that came after the battle of Vimiera, had been sent from the first with the army, Junot must have surrendered at discretion, instead of obtaining a capitulation that sent his army back to France.

In the second maxim, the causes are pointed out which afforded in 1758 a secure retreat from the landing at Cherbourg, although no regular precautions insured the measure; and those which produced the disaster at St. Cast, notwithstanding all the care General Bligh applied to the re-embarcation. The expedition to Ostend had the same defects, and produced the same results; but, with moderate weather, the naval armaments, as now organized, render such operations much more secure

Inattention to the third rule had preponderating influence at the Helder The first division on shore was paralyzed behind the defences on the Zyp until the main body arrived. Meantime the enemy, now certain of the point threatened, collected his means, and, as before stated, rendered victories so unavailing that re embarcation was purchased by heavy sacrifice

The expedition to the Helder furnishes the proofs of the fourth maxim. Had the two British corps and the Russian been combined to act simultaneously en masse from the beginning, no effectual resistance could have been made against them, but easterly winds were to convey the Russians westward, and westerly the British eastward, though both were destined for the same point at the same moment So again, the Egyptian expedition was to be sustained by a corps from India and another from the Cape At Copenhagen the two British corps united in proper time, because that which was anteriorly in the Baltic lay waiting in transports at Rugen, but the successive divisions sent to the River Plate served only to be successively defeated.

The fifth maxim is exemplified in the Walcheren expedition

The sixth maxim is obvious. Sir John Moore's expedition was on the coast of Portugal when the battle of Vimiera was fought, where it should have been present, for a corps on board ship cannot aid one on shore, and, if that is defeated, the other must retire also In the next campaign, Sir John, by several lines from Portugal, and Sir David Baird from Corunna, moved by two zones of operations, with a view

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5 Vicinity of the points of debarcation, and ending with the recommendation of measures to keep up and increase the good will of the people

OFFENSIVE OPERATIONS

of uniting their forces at a point more than 200 miles distant, then in the possession of a formidable and manœuvring enemy, though there was an unbroken Spanish corps intermediate which should have been brought into line, and a battle risked on the best available position at the forking of the road to Vigo. What the army would have done while undivided and still organized, was proved at the battle a few days later, before Corunna, nor after the action, should that fortress have been abandoned; for Soult's army could not face them in the field,—and was unprovided with a battering train.

For offensive operations against hostile insular colonies, the foregoing remarks are already sufficient; but as in general they imply not only landing but a siege, it is of the utmost importance that the most efficient means be employed for certain and rapid success, not only in the numbers and quality of the *materiel*, but in a body of Engineers and Artillery aided by Sappers and Miners, for by their means fortifications are reduced in the most speedy and least sanguinary manner; the system of destruction produced by shells and rockets may in a great measure be dispensed with, or at least confined to military defences; and delay is ever the cause of failure.

The two last maxims are of themselves sufficiently obvious, although disregard to them has been often exemplified; but some further illustrations of the principal rules of strategics may be necessary. We find, for example, in the wars of America, Lord Amherst operating by the line of Lake Champlain upon Montreal, and Wolfe by the St. Lawrence upon Quebec, both successful, and yet two years without connection. The delay may be regarded as a consequence of the enemy's defensive lines (also two in number) being internal, while the British were external, and success arose from the strategical operations being rather distinct zones than lines, and that the direction of Wolfe's upon the St. Lawrence, which brought on the battle of Quebec, severed the enemy from all connection with the other line and the interior, at the same time that by occupying the river both were entirely cut off from their fixed base in Europe.

In the American revolutionary war, we find isolated expeditions scattered over a vast continent, on no point constituting a superior army and everywhere inferior to the local militias, traversing vast woody regions, and terminating their career in defeat and capture. More recently we see them dispersed along the coast occupied in landings for trivial purposes and when re-embarked leaving the enemy the claims of successful resistance.

In British warfare, the Roman maxim, *never to act offensively on more than one point at a time* (always excluding India), is proved to be judicious by the history of events since the war of the Spanish succession when that question ought to have *been decided in the Netherlands*. The evil consequence of pursuing a multitude of offensive combinations at the same time was never better exemplified than in the failures of the simultaneous expeditions to Buenos Ayres, Constantinople, Alexandria, and Rugeo, in 1807. Small debarcations for inadequate objects on hostile coasts produce no advantage equal to the risk, expense, and hostility they foster, for the local garrison and militia of the country are soon superior in force, and a hurried return on board causes union and exultation in the enemy. The landings at St. Cast and at St. Malo, that of Sir James Pulteney at Corunna, at Alexandria and Rosetta, most of those on the shores of the United States, were fraught with danger, odium, and inadequate results. Those on the east coast of Spain during the Peninsular War form a clear exception, they had a political object of importance to hold up, an ally to join and sustain, and, above all they served as a diversion which compelled a whole hostile army to remain in that quarter.

OFFENSIVE OPERATIONS

Manœuvring lines, and those which nature has marked out, *form separate classes*

Lines of Operation

1. *Simple lines of operations* are those, when an *army operates in a single direction* from a frontier without forming detached *corps* 2 *Double and multiplied lines*, when it acts on the same frontier with *two or three* isolated corps 3 *Interior lines of operations* are so denominated when *two or more* corps are interiorly *connected while they face* an enemy posted exteriorly, whose connection is only by his flank or circuitous 4 *Exterior lines* are such as armies form when they operate upon the *two extremities of* the enemy's *front of operations, or on the two sides of two interior lines* 5 *Lines upon an extended front* are those which, though they be upon the same line, are separated into isolated divisions 6 *Deep or lengthened lines*, such as commencing at the *frontier basis, extend over a great space before they attain* their object 7. *Concentric lines* are those of several corps, or portions of corps, converging *to one point* 8 *Eccentric lines* are those of several corps, or portions of corps, *diverging towards two or more* points. 9 *Secondary lines* are those in the great combinations of armies which designate their relative connection while operating on the same frontier 10 *Accidental lines of operations* sometimes are taken when *the original plan of a campaign is altered by an unexpected event*, such as being frustrated in an offensive operation and selecting a line of *retreat towards a basis* not in the original zone of *operations*, nor *towards the starting point of the first* basis.

To illustrate some of these definitions, let us suppose two armies like the British and Prussian posted in Belgium with either offensive or defensive intentions and their magazines in the rear (*perhaps at Antwerp and Maestricht*), these places would constitute the territorial lines they have to cover, and the manœuvring lines would be in their front and to their flanks If an hostile force could place itself in their rear, about Brussels, they would be cut off from them. Now, if the allies separated, and the Prussians took post on the Meuse, towards Namur, then the enemy would be cut off from his own, but as in that case the British could not singly remain in its position, and therefore would *fall* back behind the Scheld or towards Dutch Flanders, to re-open the communication with Antwerp, then the allied armies would present two exterior *manœuvring lines*, and the *enemy* a single central line, re-opening his own communication directly with the French fortresses by a new or accidental line of operations, and attaining his object by mere strategical means But if the allied armies preferred to attack him with united forces, as both parties would engage with the chance of being cut off, the victorious would necessarily ruin his opponent. *The* movements and battles of Waterloo and Wavre would nearly represent this supposition, if the enemy's forces had moved from their base by the right bank of the Meuse, Namur had been unoccupied, and the allies had *suffered them to proceed* without counter manœuvres So again, when Melas was defeated at Marengo, he was cut off from his temporary base on the Po, and with less jealousy and more enterprise, had he fallen back towards Genoa, and, instead of *surrendering* all the fortresses, given that city in charge to the English, he would, reinforced by the 10 000 men drawn from thence, and by the supply of *materiel*, which both the British naval stores and Piedmontese arsenals contained, have resumed the offensive: and if again [illegible] have carried his forces round without a surrender or the fall [illegible]

strong case, but circumstances were such [illegible]
the results might have been very different

In the first case is already shewn the superiority of a single line, and it as well

STRATEGICS — OFFENSIVE OPERATIONS

as interior lines have manifest advantages *over every other, since they facilitate* most the great principle of carrying a superior mass upon the decisive point; for an army marching from its base by a single line of operations, the Commanding General has only two momentous chances to provide against: 1st, that of being attacked unawares; and 2nd, of being turned and severed from his base. If he take the *initiative*, manœuvring with the intention of attacking, he will keep the adversary in check, and prevent a counter-offensive; and if, in these movements, he can gain the hostile line of territorial operations, or throw his masses centrally, so as to prevent the enemy's corps uniting, he may totally ruin him. This was the aim of Napoleon in 1815; his concentrated masses were alternately to crush an opposing army, while an inferior corps kept the other in check; selecting the offensive line from behind fortresses at his pleasure, he could fall upon the allies before they were concentrated. The plan of his operations was good, had it been acted on a day earlier; and a day later he would not have been allowed to become the assailant. His momentary successes were due to the operations of a single against double lines; but when his intentions were sufficiently developed, and when the necessarily extended positions were drawn together, the continuance of the same idea became rashness, *for* the two allied armies were united.

An army moving upon exterior, double, or multiplied lines, is weakened in proportion as it is subdivided; the casualties in its combinations are greatly increased by the chances of accidents, misunderstandings, non-arrival of orders, and delays; errors are not so readily discovered or rectified, and a single misfortune in any one part paralyzes the whole. To the vicious system here noticed, must be ascribed the greater part of the failures of the Austrians, and more particularly of Alvinzi in Italy; and the Seven Years' War is rich in examples of success and reverses, mainly to be ascribed to the use made of single and double lines of operations. In the wars of the French Revolution, little was done by either party, scientifically considered, that deserves commendation: external and excentric lines, permanent positions, great detachments, were adopted by all, with manœuvring armies on the side of the allies; a belt of fortresses, numerical superiority, and, above all, a geographical frontier, which made all the movements of the French army comparatively single against double, [illegible] of the left (Dunkirk), and having by this mass ruined the opponent (the Duke of York), to move it to the next, opposite Charleroy, where, being thus again vastly superior, it broke the grand Austrian army; then again, proceeding to a third (Sombre and Meuse), and finally to a fourth army on the Rhine, each in turn becoming thereby superior, success was obtained for the whole campaign.

Napoleon manœuvred always *on single lines, and in directions to cut off his opponents* from all their resources: his strategics and battles were ever on the same principle, and, adding to these extraordinary activity and daring, he prostrated all the continental powers. But his deepened or lengthened lines of operations became boundless, and his daring, rashness; still, the value of the true principles of war made him successful against the false maxims of the enemy. In the Russian campaign, his single and internal lines broke through the multiplied and extended lines of the Russians, till their depth, and the change of the Muscovite system after the battle of Borodino, aided by the climate, exterminated his forces; and new armies could not again restore the superiority. Meantime the Duke of Wellington began in the Peninsula by creating a military base, then, although he manœuvred with inferior forces, by carrying the mass alternately on the north and on the south of the

Tagus, he gradually widened and strengthened his frontier. Next, after having finally checked Massena in the position of Torres Vedras, he commenced operations on a single prolonged line, always in the direction of the enemy's communications with France, and, therefore, so dangerous to them, that in order to compel his army to retreat towards the Portuguese frontier, they were obliged to collect far superior forces, and to abandon the whole south of Spain. Soon after, Madrid itself, and then the north, were similarly lost by the operations and movement of battles ever turning the communications of the French, and the Pyrenees themselves gave no lasting security; the territory of France being first invaded on that side, and a British army operating in Gascony, before the Rhine or the Rhone were crossed by the allies. No stronger example of the superior advantage of a right use of lines of operations in the direction of an enemy's flank and rear can be produced, than the result of these operations in the north, still further made manifest when they are compared with that on the south of the Tagus, where the victory of Talavera was useless and followed by retreat. It was a great warning given to Statesmen, not to violate the first principles in war upon bare political calculations, or on the questionable sincerity of remonstrances from inefficient allies.

From the results of the scientific campaigns of the last wars, the value of the principles above indicated may be summed up under the following heads:

1. A double line of operations is advantageous if the enemy likewise acts upon two lines, provided these be exterior and at a greater distance to operate simultaneously than your own upon the same field of action.

2. An army having interior lines, being more concentrated than those of the enemy, can by strategical movements destroy first one, then the other parts of his forces, by alternately carrying its masses upon each point,—as was exemplified by the King of Prussia in 1758, and subsequently in the revolutionary wars at Mayence, Wurtzburg, Emendingen, at Lonato, Castiglione and Bassano, Stockach and Zurich, Abendsberg and Eckmuhl, as well as in the Peninsula, before noticed.

3. To effect this purpose a corps is left to occupy the attention of the army for a short period, by various movements, or by an intrenched position, in all cases to act really on the defensive, retarding the enemy's advance at defiles, bridges, &c., until, by slow retreat, time has been given for the main army to strike the intended blow, and then the order of operations is reversed by the retreating corps being reinforced, till it is in a condition to resume the offensive with superior forces.

4. Thus, with equal forces, an external double line will always be worsted by an internal, because these last being in closer connection, can most readily reinforce each other, provided their Commander manœuvres with intelligence and rapidity. Even the ignorant energy of Tippoo Saib proved in several wars the advantage of central operations against external lines, such as Lord Cornwallis and Abercombie, with their allies, used against him.

5. A double line of operations becomes still more dangerous when its parts are separated by several days' march.

6. Simple and interior lines, on the contrary, are always most safe, because they admit the mass of forces to act against the divisions of the enemy, if he be so imprudent as to leave one or more in that condition.

7. A double line of operations, however, may be adopted with success, if the forces employed so greatly exceed the enemy's as to outnumber them on both its parts.

8. Two interior lines, mutually sustaining each other, and facing two exterior

lines at a certain distance, must avoid being compressed into a small area, for the two hostile bodies might then co-operate simultaneously

9 But they should not manœuvre at too great intervals for the enemy, by a sudden advance on one, might have time to crush it while it is weakened by detachments to the other, and thus gain a decisive advantage

10 It being the advantage of a Commander to divide and isolate an opponent's army, his manœuvres should never have the object of drawing his whole forces unitedly upon him, notwithstanding Tempelhoff's boast that Frederick the Great effected this in 1760

11 When armies operating exteriorly amount to above 100 000 men on each line, as occurred in Saxony (1813), and in Champagne (1814) they possess a consistency that is not so easily affected by interior lines they can recede and advance till the intervening area is so diminished that the forces within it risk to be simultaneously attacked, or they must escape in a direction least expected, that is, where the retreat is most baneful to themselves Proofs of this law are found in the operations about Leipzig and in the last strategical movement of Napoleon in 1814, by which he lost his communication with Paris and his crown

12 But notwithstanding these events, concentrated lines maintained him in 1813 about Dresden, and the next year in Champagne, until yielding more to temperament than necessity he manœuvred excentrically with inferior forces at all points, and at the same moment in Bohemia, Silesia, and the sands of Berlin, and suffered reverses in all so again the next year in France, while the allied forces were in extreme difficulty for subsistence, his impatience to act on the offensive broke through all the principles of war, and Paris was lost without an admissible reason The history of individual and national temperament in war is indeed a subject replete with fearful lessons, if it were properly handled. Marlborough in 1711, counteracted by the ministry of his own sovereign, crowned the greatest of his manœuvring campaigns by forcing the French lines and the capture of Bouchain, solely by playing upon the temperament of Villars whose irritable vanity is confessed in his own Memoirs Had Eugene, the year after counteracted the French march upon Denain, by boldly manœuvring across the Escaillon and Selles upon their communications and rear, they must have immediately retreated or been cut off from their basis of operations

In order to complete the view of territorial and manœuvring lines, it is requisite to consider them as they are affected by the configuration of frontiers, for the base of operations depends thereon as is manifest from proofs already given

1 Only one army should operate on the same frontier, though reserves, &c may be kept in second line That army is based usually on the last line of fortresses the most defensible river, or mountain chain whence offensive movements can proceed, and to which defensive refuge must be had with the greatest trust for safety

2 An army may have successive bases A French basis, defensively viewed from the side of Germany, would be primarily on the Rhine, second on the Moselle third on the Seine, and fourth on the Loire

3 A first basis becoming by the reverses of an army exposed to the enemy its character is changed to a line of defence particularly if there be fortresses upon it thus the upper Rhine, a broad and rapid stream with fortifications on many points forms an excellent base and defensive line, for none are good that have not more than one fortress upon them

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a selection of the most intelligent officers to command them It is the best *practical* school of war

Battles are either offensive or defensive; therefore what is recommended to be done for gaining the first is most to be guarded against in the second They are reducible to three systems 1, includes defensive battles where the enemy is expected in a *strong position with no other intention than that of maintaining it* Such were those of the French under Tallard at Blenheim, of Villeroy at Ramillies, of Marsin at Turin, of Villars at Malplaquet, of Saxe at Fontenoy, Daun at Torgau, and the results shew their general disadvantage 2 is the opposite system, wholly offensive It consists of movements of attack wherever the army may be found Such were those of Marlborough at *Blenheim, Ramillies, and Oudenarde Frederick at Leuthen, Zorndorff*, and Torgau; Napoleon at Jena and Ratisbonne; Wellington at Vittoria, and the allies at Leipsig 3, is the middle term between the above It consists in selecting a position carefully reconnoitred beforehand in its strategical applicabilities and advantages of ground, there to await the enemy, and to fix upon the proper moment of passing from the defensive into offensive measures with the best chances of success To these belong the battles of Rivoli and Austerlitz, of Blucher at Katzbach and Laon, and of Wellington at Salamanca and Waterloo The selection of the class of action is not always optional, the circumstances of the moment, the character and number of the troops in hand, the season and nature of the country and ground, all enter into the consideration, and leave *only the following* generalities for data.

Orders of battle, or the most appropriate *disposition for leading* troops into action, should possess the inherent qualities of mobility and solidity To attain these two objects, troops which are to remain on the defensive should be partly deployed and partly in column, as the allied army was at Waterloo, and the Russian at Eylau But the corps destined to attack a decisive point should be disposed into two lines of battalions formed into columns Such were the British at Roleiça, and the centre and left of Napoleon's grand army at Dresden Each column may be in grand divisions of battalions, and if it is considerable in depth, may be best formed on two central grand divisions, which, moving forward contiguously readily constitute a line by each marching up obliquely to right and left A beautiful example of this formation was produced by Marshal Lehwald at the battle of Jagerndorff

1 The best mode is to act offensively on all occasions when the troops are inured to war and the ground offers no extraordinary features especially

2 When the strategical circumstances of the parties are such that one is obliged to attack *the other without considering the localities*, as for instance, to prevent the junction of two hostile armies, or to crush an isolated corps, &c

3 But the defensive is advisable where the topography of a field of battle is difficult of access, from natural or from artificial causes and the army is composed *of different nations trained in different manners* and imbued with *different* feelings it is preferable to receive the attack in a well selected position, with the determination of assuming the offensive when the enemy shall be exhausted by the first efforts

4 Also when particular reasons such as an extreme inferiority of numbers, *forbid any other than strictly defensive* measures, such as Eugene took at Chiari, Abercrombie on the Zyp, and Moore at Corunna.

There are strategical battles so much affecting the flank and rear or the com-

munications of the defensive party, that sometimes they are decisive of a campaign such was that of Marengo, and again, as a battle, more complete at Vittoria.

Orders of Battle

Battles, again, whether offensive or defensive, notwithstanding all the varieties of ground and changes of position, are reducible to three orders, each subject to some modifications

1 The simple parallel order, or that where the hostile forces face each other in parallel lines, to advance or receive the attack In these, accident or some condition of superiority in courage, artillery, or discipline, decides the contest, and not the capacity of the commanding General.

2 Where no other combinations are practicable, there is the second order, or that with parallel lines reinforced upon one extremity To this class especially if dispositions with an angle to the front or rear are included, most of the great victories of ancient and modern times may be ascribed, for although it is not the most perfect in theory, it is the most constantly applicable in practice, under almost every possible character of ground or counter disposition of the enemy

3 The oblique order of battle is the third and the best class of tactical dispositions, but in the application great simplicity of combination is necessary, and great prudence in the execution Against a manœuvring army well commanded it will always be difficult to apply it, but when produced the effect is instantaneous and decisive it is the triumph of discipline and of grand manœuvre

Positions

On the extensive subject of position, the following maxims offer some particulars 1 The best military positions cannot cover a State merely by being occupied and maintained 2 Every position has two keys or decisive points one is the strategical, whereon the army hinges in relation to its communications with the base of operations, and the other, depending on the nature of the ground is the topographical which being attained by an enemy, dispossesses the defendant In this case the defeated army, as at Neerwinden, in 1693, and at Neerlanden in 1793 is merely driven back upon its line, but in the first mentioned it is cut off from it as the French were at Vittoria, and therefore the result if properly followed up by the conqueror, is always disastrous to the routed 3 An army in position to risk a battle on the spot should have the front and flanks most carefully reconnoitred and watched, its internal communication opened and connected and if there be time the roads in rear, to the distance of a march at least examined and sketched 4 Strong corps are not required to watch the avenues, the service is performed better by numerous small posts The practical importance of the two last rules is exemplified by the surprisal of the Prussians at [illegible], of Korsakow at Zurich and Murat at Tarutina. 5 On ground of difficult access, such as gardens enclosures

enemy in the same order If it be desired [illegible] a part may be deployed, behind which close columns should be concealed. 6 A superior army should never wait to be attacked, still less when deployed into line if compelled to remain in its post no more troops should be formed in line than are requisite to repel the enemy, while the remainder formed in columns, should be so placed as to strike a decisive blow, as Lord Hill's corps did at Waterloo. 7 Villages, farms or cassinos covering the front of armies, should be occupied by light troops

Abattis will always be found a very useful and effective auxiliary to the defence of picquet houses or isolated posts if judiciously placed within range of musketry. If placed close in front of the windows on the ground floor or to cover the entrance door it will be extremely difficult for the enemy to force his way into the building.

In field works it is very often equally difficult to procure timber to form a barrier to secure the gorge; this may be readily effected if trees are within a short distance of the works by blocking up the entrance with an abattis.

AMMUNITION.—See also PYROTECHNY.

The following Table refers to Sea Service as well as to Land Service Ammunition, the whole being prepared by the Ordnance chiefly at Woolwich, and supplied for either of the above as demanded on requisition, Naval or Military.

General Table of the Ammunition of Ordnance, &c. shewing the nature and weights; also the dimensions of the boxes or packing cases usually employed in Stowage and Transport, their weights empty and filled, contents and numbers as numbered in the Pattern Rooms at Woolwich.

		Weight of 1	Number of Contents	Weight of Box: Empty	Weight of Box: Filled	External dimensions of Box: Length	Breadth	Depth	Number in Pattern Room
		lbs. oz.		lbs.	lbs. oz.	ft. in.	ft. in.	ft. in.	
68-pr.	Grape quilted	50 8	3		1 6 8	3 2¼	10½	1 1½	
	Grape in case	30 13	3		177 13			„	
	Common shells	42 2	3	33	151 6				1
	Round carcass	49	3		169				
	Spherical case	6 4	3		205 13				
	Common case	47 3	3						
	Oblong carcasses		3	39	107 7	3 3¼	„ 10½	1 3½	2
	Oblong light balls	35 13	3						
42 pr.	Grape	41 7	4	29	193 13	2 3¼	9	1 1¼	3
	Spherical case	39 2	4		190 8				
	Case gun	41	4		201 8				
	Case carronade	33 13	4	29	139 4	2 3¼	9	1 3½	4
	Grape carronade	33 6	4		191 8				
32 pr.	Case gun	35 1	4	27	167 4	2 2½	8½	1 3½	5
	Grape gun	27 13	4	21	161 4	3 2¼	6¼	1 6¼	6
	Case carronade	20 13	4		106 12				
	Grape carronade	29 8	4	23	141	2 2¾	8¼	1 3¼	7
	Spherical case	27	4		139				
	Round carcasses	23 8	4		115 12				
24 pr.	Case gun	24 3	6	21	165 12	1 7½	1 1½	1 1¼	8
	Case carronade	16 3	6	25	122 5	1 6¼	1 4¼	9½	9
	Grape carronade	20	6		102				
	Grape gun	20 10	6	22	165 13	2 4¼	„ 10½	9	10
	Oblong carcasses		6						
	Light balls	9 11	6		90 2				
	Flam cart. 9 lb.	8 3	6		5 12	1 6¼	1 0¼	1 3	1 c
	Round shot strapped	23 7	6		163 10				
	Case 10 on ride How	16 3	6	19	228 3	1 7½	1 1¼	9	11
	Carcasses round	11 3	6		131 3				
	Shells, common	14 15	6		104 15				
	Flam cart. 7½ lb. How	3 9	12	24	54 12	2 4¼	„ 10½	8	12 c
5½ in How	Spherical case	23 10	6	27	139 4	1 9	1 2¼	11	12
	Common case	14 11½	6	22	228 8	1 7½	1 12	„ 10½	13
9 pr.	Case gun	19 11	9	22	180 8	1 10½	1 8½	1 3¾	14
	Case wood ends		9						
	Round s strapped	8 6	9	20	15	1 10½	1 6¼	„ 9	15
	Carcasses round	11 13	9		114 8				
	Spherical case	13 11	9	24	147 8	2 1¼	1 1¼	8	16
	Grape carronade	15 3	9	20	144	1 10½	1 8½	„ 10½	17
	Grape gun	16 13	9		234				
	Flam cart. [illegible]	6 1½	9	23	73 12	1 10½	1 5	1 2	8 c

TABLE—*continued*

		Weight of 1	Number of Contents	Weight of Box		Exterior dimensions of Box			Number in Pattern Room
				Empty	Filled	Length	Breadth	Depth	
		lbs oz		lbs	lbs oz	ft in	ft in	ft in	
12 pr	Case gun S S *	11 11	12		164 8				
	Grape gun	11 1	18		158 12				
	Grape carronade	10 9	12	26	133 12	2 8½	11½	10½	12
	Case carronade	8 4	18		125				
	Case howitzer	11 8	12		161				
	Round strapped	13 8½	12		171				
	Carcasses round	8 4	15	81	123	2 8½	11	8½	19
	Shells common	8 8	12		126				
	Spherical case gun	10 14	15	25	153 8	2 8½	11½	6½	20
	Spherical case how	10	15		115				
	Case Land Service gun	17 4	6	17	120 8	1 3½	11½	1 0½	21
	Case How tzer or 1	9 4	15		120				
	Carcasses oblong		15	21		2 8½	11½	9½	23
	Light-balls	8 4	15		81				
	Fl cas gun 1 lb	4 1	12	26	4 12	2 4½	10¾	1 8½	3 c
	Fl cas how 1 lb 4 oz	1 8	36	27	1 4	2 0½	1 0½	1 1½	11 c
	Fl cas how 1 lb 14 oz	1 13	81	84	70 8	2 2¾	10½	1 1	13 c
9 pr	Case gun	13 9	12	33	166 8	2 2	10½	11½	23
	Grape gun	8 12	15		129				
	Case gun S S	9 10	12	23	139 8	2 3	10½	10	24
	Grape carronade	9 1	12		131 12				
	Round strapped	9 2	12	18	127 8	2 2	10½	7½	25
	Case carronade	6 7½	12		93 10				
	Spherical case	8 2½	12	23	122 11	1 4½	11½	1 2	26
	Flan cart gun 3 lb	3 1	12	33	69 12	2 1½	10½	11½	4 c
6 pr	Round strapped	6 1½	24	24	1 8 4	2 0½	9½	11½	27
	Case L S †	8 13	12		129 12				
	Case S S	8 10	24	23	158	2 6½	1 1	8½	28
	Grape S S	6 6	20		130 8				
	Case carronade	4 9	20	23	114 4	1 8½	9½	1 2½	29
	Grape carronade	8 2	20		123 8				
	Spherical case	6 7½	24	29	160 4	2 3½	10	1	30
	Flan cart 2 lb	2 1	24	21	60 8	2 6½	1	11½	8 c
	Flan cart 1½ lb	1 9	34	28	65 9	2 6½	1	9½	6 c
3 pr	Round strapped	2 1	30	18	109 14	1 4½	10½	10½	31
	Case L or S	4 3½	30	25	131 9	2 6½	10½	2½	32
	Grape gun	2 9	30		101 14				
	Fl. cart. 1 lb	1 0½	30	26	56 15	2 6½	10½	10	7 c
	Fl. cart. 12 oz fixed to rd shot	3 13½	12	21	67 2	1 7½	11½	1	8 c
	Fl. cart. 12 oz fixed to case shot	5	13	24	81	1 7½	11½	1 2½	9 c
2-pr	Case	2 4	60	26	161	2 2	1 2½	7½	33
1½ pr	Case	1 12½	38	19	106 1	2	1 1	7½	34
1 pr	Case	1 8	50	15	90	1 9½	11½	8½	35
	Round strapped	1 1	50	15	68 2	1	1	9	36
13 in	Shells	192 2	1	29	271 2	1 3½	1 3½	1 4	37
	Carcasses round	210	1		239	1 3½	1 3½	1 4	
10 in	Shells	85 3	2	26	196 6	1 10½	1 0½	1 1	38
	Carcasses round	99 2½	2		222 8				
	Case shot	85 6	2		201 12				
	Carcasses oblong		2	34		1 10½	1 0½	6½	39
	Light-balls	76 8	2		187				
Bursters	15 oz	15½	26		49 10				
	10	10½	45		52 8				
	7½	8	60		51				
	7	7½	60		49 8				
	6	6½	60	21	45 6	1 8½	11	1 0½	13 c
	5	5½	72		43 12				
	4½	8	72		43 8				
	2½	4	96		43				
	3½	3	120		43 8				

* S S Sea Service † L S Land Service

Abattis will always be found a very useful and effective auxiliary to the defence of picquet houses or isolated posts, if judiciously placed within range of musketry: if placed close in front of the windows on the ground floor, or to cover the entrance door, it will be extremely difficult for the enemy to force his way into the building.

In field works it is very often equally difficult to procure timber to form a barrier to secure the gorge; this may be readily effected if trees are within a short distance of the works, by blocking up the entrance with an abattis.

AMMUNITION.—See also PYROTECHNY.

The following Table refers to Sea Service as well as to Land Service Ammunition, the whole being prepared by the Ordnance, chiefly at Woolwich, and supplied for either of the above, as demanded on requisition, Naval or Military.

General Table of the Ammunition of Ordnance, &c., shewing the nature and weight; also the dimensions of the boxes or packing cases usually employed in Stowage and Transport; their weights, empty and filled; contents and numbers, as numbered in the Pattern Rooms at Woolwich.

Nature		Weight of 1	Number of Contents	Weight of Box: Empty	Weight of Box: Filled	Exterior dimensions of Box: Length	Breadth	Depth	Number in Pattern Room.
		lbs. oz.		lbs.	lbs. oz.	ft. in.	ft. in.	ft. in.	
68-pr.	Grape quilted	36 8	3	31	1?6 9	2 2½	,, 10½	1 1½	1
	Grape in case	30 11	3		1?? 13	,, ,,	,, ,,	,, ,,	
	Common shell	42 2	3		131 8	,, ,,	,, ,,	,, ,,	
	Round carcass	44 ,,	3		169 ,,	,, ,,	,, ,,	,, ,,	
	Spherical case	61 6	3		209 15	,, ,,	,, ,,	,, ,,	
	Common case	47 3	3						
	Oblong carcasses		3	24	167 7	2 2½	,, 10½	1 1½	2
	Oblong light balls	35 11	3						
42-pr.	Grape	41 7	4	29	193 12	2 2½	,, 9	1 1½	3
	Spherical case	36 2	4		140 8				
	Case gun	44 ,,	4	30	214 9	2 4½	,, 3	1 2½	4
	Case carronade	30 11	4		139 6				
	Grape carronade	34 6	4		161 9				
32-pr.	Case, gun	35 1	4	37	167 8	2 2½	,, 9½	1 2½	5
	Grape gun	29 13	4	23	144 4	2 2½	,, 9½	1 9½	6
	Case carronade	24 11	4	23	160 12	2 2½	,, 9½	1 9½	7
	Grape carronade	30 8	4		141 ,,				
	Spherical case	30 ,,	4		179 ,,				
	Round carcass	30 3	4		213 12				
24-pr.	Case gun	31 3	6	21	1?? 12	1 7½	1 1½	1 1½	8
	Case carronade	11 3	6	21	172 3	1 6½	1 1½	9½	9
	Grape carronade	24 ,,	6	27	167 ,,	2 4½	,, 10½	,, 3	10
	Grape gun	23 10	6		1?5 13				
	Oblong carcasses		6						
	Light balls	3 15	6		88 7				
	[illegible]	9 3	6		79 12	1 6½	1 4½	1 3	10
	Round shot, strapped	24 7	6	23	1?? 10	1 2½	1 3½	,, 9	11
	Case lead ends, 11 oz	15 2	6		113 2				
	Carcasses round	11 2	6		104 3				
	Shell, common	16 15	6		108 10				
	[illegible]	3 8	12	24	34 14	2 4½	,, 13½	,, 8	10
[illegible]	Spherical case	33 10	4	37	150 9	2 9	1 3½	,, 11	12
	Common case	16 11½	6	22	119 8	1 7½	1 ½	,, 10½	13
[illegible]	Case gun	25 11	3	27	100 8	1 11½	1 4½	1 9½	14
	Case round ends		9	28	1?? ,,	1 10½	1 9½	,, 3	15
	Round, strapped	16 8	9						
	Carcasses round	11 11	9		114 3				
	Spherical case	21 11	9	24	149 8	2 3½	1 1½	,, 9	16
	Grape carronade	15 8	9	30	144 ,,	1 14½	1 4½	,, 11½	17
	Grape gun	1?9 1?	9		1?4 ,,				
	[illegible]	8 1½	6	23	75 14	1 4½	1 1	1 2	18

TABLE—*continued*

Calibre	Description	Weight of 1 (lbs oz)	Number of Contents	Weight of Box: Empty (lbs)	Weight of Box: Filled (lbs oz)	Exterior dimensions of Box: Length (ft in)	Breadth (ft in)	Depth (ft in)	Number in Pattern Room
12 pr	Case gun S S *	11 14	18		168 8				
	Grape gun	11 1	12		152 12				
	Grape carronade	10 8	12	26	132 12	2 2½	„ 11½	„ 10½	18
	Case carronade	8 4	12		125 „				
	Case howitzer	11 8	12		164 „				
	Round, strapped	10 2½	12		174 „				
	Carcasses round	2 4	12	21	123 „	2 2½	„ 11	„ 8½	19
	Shells common	8 8	12		126 „				
	Spherical case gun	10 14	12	25	135 8	2 2½	„ 11½	„ 6½	20
	Spherical case how	10 „	12		115 „				
	Case Land Service gun	17 4	6	17	140 8	1 2½	„ 11½	1 0½	21
	Case Howitzer or 4	8 4	12		120 „				
	Carcasses oblong		12	21		2 5½	„ 11½	„ 9¾	22
	Light balls	2 4	12		81				
	Fl car gun 4 lb.	4 1	12	26	74 12	2 4½	„ 10¾	1 0¾	2 c
	Fl car how 1 lb 4 oz	1 8	36	27	74 4	2 0½	1 0½	1 1½	11 c
	Fl car how 1 lb 14 oz	1 15	24	24	70 8	2 2¾	„ 10½	1 1	12 c
9-pr	Case, gun	12 2	12	23	180 2	2 2	„ 10½	„ 11½	23
	Grape gun	8 12	12		128 „				
	Case gun S S	9 10	12	23	133 2	2 2	„ 10½	„ 10	24
	Grape carronade	9 1	12		131 12				
	Round strapped	9 2	12	18	127 8	2 3	„ 10½	„ 7½	25
	Case, carronade	6 7½	12		95 10				
	Spherical case	8 2½	12	23	140 11	1 4½	„ 11½	1 2	26
	Flan cart. gun 3 lb	2 1	12	23	59 12	2 1½	„ 10½	„ 11¾	4 c
6-pr	Round strapped	6 1½	24	24	170 4	2 0½	„ 9½	„ 11¾	27
	Case L S †	8 13	12		139 12				
	Case S S	5 10	24	23	138 „	2 6½	1 1	„ 8¾	28
	Grape S S	5 6	20		130 8				
	Case carronade	4 9	20	23	114 4	1 8½	„ 9½	1 2½	29
	Grape carronade	6 2	20		125 8				
	Spherical case	5 7½	24	29	160 4	2 3¾	„ 16	1 „	30
	Flan cart 2 lb	2 1	24	21	60 8	2 6½	1 „	„ 11½	5 c
	Flan cart 1½ lb	1 9	24	28	63 2	2 6½	1 „	„ 9½	6 c
3 pr	Round strapped	3 1	30	18	109 14	1 4¾	„ 10¾	„ 10½	31
	Case L or S	4 8½	30	25	151 6	2 6½	„ 10½	„ 8¾	32
	Grape gun	2 9	30		101 14				
	Fl cart. 1 lb	1 0½	30	26	56 13	2 6½	„ 10½	„ 10	7 c
	Fl cart. 12 oz fixed to fd shot	2 13½	12	21	67 2	1 7½	„ 11½	1 „	8 c
	Fl cart. 12 oz fixed to case shot	5 „	12	24	84 „	1 7½	„ 11½	1 2½	9 c
2 pr	Case	2 4	60	26	161 „	2 2	1 2½	„ 7½	33
1½ pr	Case	1 12½	50	19	108 1	2 „	1 1	„ 7½	34
1 pr	Case	1 8	58	12	90 „	1 9¾	„ 11¾	„ 2¾	35
	Round strapped	1 1	58	15	68 2	1 „	1 „	„ 9	36
13 in	Shells	192 2	1	29	221 8	1 3¾	1 3½	1 4	37
	Carcasses round	210 „	1		230 „	1 3¾	1 3½	1 4	
12 in	Shells	25 3	2	25	196 6	1 10¾	1 0½	1 1	38
	Carcasses round	98 2½	2		222 5				
	Case shot	85 6	8	24	204 12	1 10¾	1 0½	„ 6½	39
	Carcasses oblong		8						
	Light-balls	76 2	8		127 „				
Bursters	15 oz	„ 15½	36		49 10				
	12	„ 10½	48		52 8				
	7½	„ 8	60		81 „				
	7	„ 7½	60		49 2				
	6	„ 6½	60	21	45 6	1 8½	„ 11	1 0¾	13 c
	5	„ 2½	72		43 12				
	4½	„ 2	72		43 8				
	3½	„ 4	26		43 „				
	2½	„ 2	120		43 8				

* S S Sea Service

† L S Land Service.

$\frac{12}{13}$ and $\frac{5}{13}$. Thus a wind N N E 65 is equivalent to N 60 and E 26 The oblique winds have for their multipliers $\frac{7}{10}$ and $\frac{71}{100}$, and for the remaining points $\frac{38}{100}$ and $\frac{92}{100}$ may be used, but such minuteness can seldom be necessary

Indications of Whewell's Anemometer

JANUARY, 1837.

1	N 12	Total 12	12	N 3, N E 0	Total 3	22	S S E 43	Total 43
*2	N N W 8, S W 1	9	*13	S S W 45, S W 9	54	*23	S 22, S S W 34	56
3	W 7	7	14	S W 11, N W 58	69	24	S S W 44, S W 10	54
4	S W 11	11	*15	N N W 56	56	25	S W 7, E 8	15
5	S W 11	11	16	N N W 7, W S W 2	9	*26	E N E 44	44
6	S S W 29	29	17	S W 2, W N W 1	3	27	E N E 65	65
*7	S W 31	31	18	N W 0	0	*28	E N E 48	48
8	W S W 29	29	19	E N E 0	0	29	N E 34	34
9	S S W 26	26	20	E N E 12	12	30	E N E 10, S E 15	25
*10	S S W 76	76	21	S S E 6	6	*31	S S E 48	48
11	S W 13, N 25, W N W 4	42						

FEBRUARY

1	S S E 5, S 5, S S E 8	Total 18						
2	S 2	2						
3	S E 14	14						
4	S E 30	30						
5	S E 17, S S E 10	27						
6	S S E 27	27						
7	S S E 31, S 7	38						

* The asterisk indicates the times when the instrument was wound up

Summary

	N	E.	S	W.
Jan 1 to 14 . .	. . .	. . .	[illegible]	[illegible]
" 14 " 18 . .	121	. . .	. . .	59
" 21 " 23 . .	. . .	. . .	[illegible]	[illegible]
" 26 " 30 . .	69	[illegible]	. . .	. . .
" 31 " Feb 7 .	. . .	[illegible]	[illegible]	. . .
	[illegible]	[illegible]	[illegible]	[illegible]
			[illegible]	[illegible]
			S [illegible]	E [illegible]

Various modes have been devised of exhibiting graphically the results of wind observations The most simple is to plot the course like a traversed survey; *i. e.* starting from a given point, draw a line in the direction of the first recorded wind, of such a length as represents its magnitude. From the extremity of this line draw another, representing the direction and magnitude of the second recorded wind, and so on; or, lines may be drawn radiating from a centre to all the points of the compass; each line being made of length proportional to the magnitude it records, whether of prevalence or of force. The extremities of the lines being joined, a polygon is formed, it may be for a month. The comparison of polygons formed from several recurrences of the same month will give a type of that month, and their combination a type of the year. The same may be expressed by curves formed from ordinates and abscissæ, or in various ways suitable to particular purposes, which it is not necessary to dwell on

There is one mode, however, so ingenious that it deserves especial mention. It is that devised by M. Léon Lalanne for exhibiting three variables. It will easily be understood by considering that we can fix any point on a plane by the intersection of two co-ordinates; and if we suppose each of these co-ordinates to represent a variable, and a perpendicular to be erected on that point, of such a length as shall represent the third, we shall have a net-work of squares, and from every intersection a perpendicular projecting upwards: the summits of these perpendiculars, varying in length, will represent, as it were, the surface of a model of ground. But the difficulty remains of exhibiting on the plane of the base the position which the summit of the perpendicular occupies in space. This difficulty, however, is precisely the same as that felt in representing the undulations of ground in a plan; and the application of contours, so successful in the latter, is equally descriptive in the former Suppose we desire to exhibit the prevalence of particular winds at particular places for each month of the year; say at Dum Dum, near Calcutta. (Plate III fig 15) [This is the example given by M Lalanne] The winds range up the sides of the rectangle, the months at its top and bottom, the imaginary lines perpendicular to the plane indicate the proportional prevalence of the winds in each month, their height being represented by figures of altitude, and all those which are equal being joined to form the curves, or contours In this figure M. Lalanne has chosen to divide the month into twentieths. Following now the vertical line which indicates the month of September, for instance, till we come to the horizontal line marked East, we find ourselves on a contour marked 4, which indicates that during $\frac{4}{20}$ or ·2 of the month of September the wind was easterly, and so on A curve constructed of abscissæ and ordinates in the usual way would obviously be analogous to *a section* of the ground of which the figure of M Lalanne may be considered for the moment as a topographic representation, but a separate curve must be made for each month to afford the same information

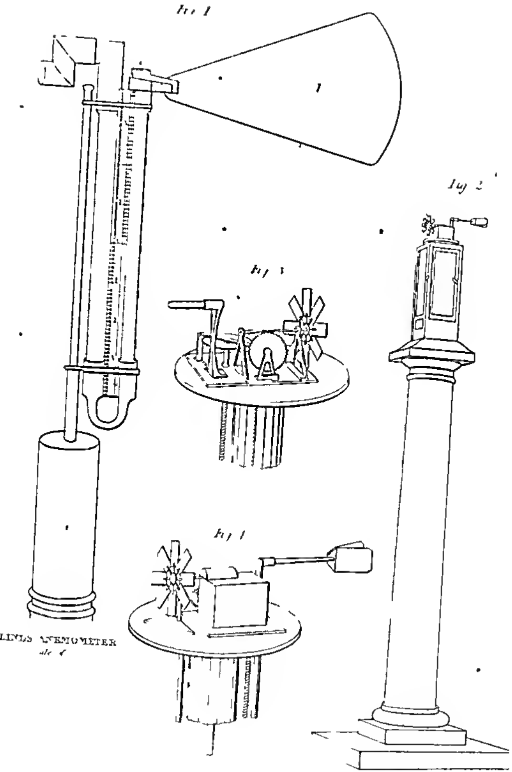
Those which correspond to hours are stronger than the rest, and half an inch apart; the intermediates shew decimals of the hour The mode of using it is this the pencil p' being removed, the date is written on r near its pencil, the clock is then wound up, and p draws a line from the circumference to the centre The paper on r' is then removed or shifted, and if another be placed, it is similarly dated, with the addition of the degree, which is set at the fiducial line, and the pencil p' is replaced Then, during the ensuing twelve hours, the action of the clock carries the pencils from the centre to the circumference If there were no wind, they would merely draw radial lines, but *in general p traces a spiral*, and *p' shades an irregular sector*. The clock should be adjusted so that the twelve hour-circles should be exactly traversed In general, a space-paper may contain four or six spirals dating each winding line, and a direction one, two or three sectors, shifting the zero point for each This zero, in my practice, represents a wind from the south, and the graduation goes round from west to north The papers are finally fixed with a weak solution of mastic in spirit, and preserved for reference

In reducing these diagrams to a form available for computation, no system appeared preferable to the method pointed out by Dr Whewell in his Memoir In the first instance, *the centres of the papers are restored*, in the space papers, drawing radii through the intersections of the spirals with the hour-circles, the graduation gives the *hourly spaces*, which, *if necessary, are corrected for friction; these are* tabulated In a second column is entered the direction at each hour This is found by bisecting the arc of the hour circle, which is shaded by the pencil The mean direction during each hour will, in general, not differ from the mean of those at its beginning and end, but if the eye perceives that this is not the case, those for the decimals of the hour may be taken From this are computed two rectangular coordinates, which are given in the third and fourth columns, w the motion of the wind from the west, s that from the south These are obtained by multiplying the hourly spaces into the sine and cosine of the mean direction

As an example, the reductions are annexed of the twelve hours during which the centre of the cyclone of March 1850 passed the Observatory, as one which will *illustrate the process in an extreme case*

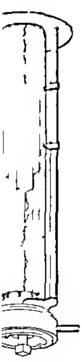
Date	Space.	Direction	W	S
March 29, 10 P.M. .	m	303°·8	m	m
11 . .	33·5	313·8	−26·1	+21·0
12	32·0	320·5	−26·8	+23·4
1 A.M. .	31·1	307·3	−22·4	+21·5
2 .	29·4	314	−22·3	+19·1
3 .	30·3	294·7	−25·0	+17·1
4 . .	31·5	77·2	−19·9	−24·4
5 . .	30·5	78·8	+29·9	+ 6·3
6 . .	31·1	66·7	+29·7	+ 9·3
7 . .	31·1	69·1	+28·8	+11·7
8 . .	32·9	88·2	+24·5	−22·0
9 . .	36·6	88·2	+33·4	+ 1·0
10 . .	37·5	99·9	+37·5	− 0·3
Sum	383·5		+46·3	+83·7

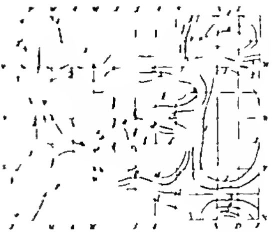
The means for the two irregular hours are taken from the reading of each tenth. We have $\tan D = \frac{46 \cdot 3}{83 \cdot 7}$, which as both are positive must be in first quadrant, therefore

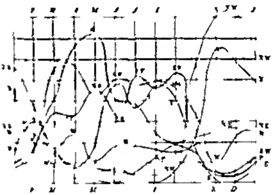


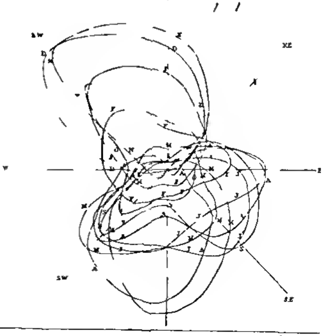
LINDS ANEMOMETER

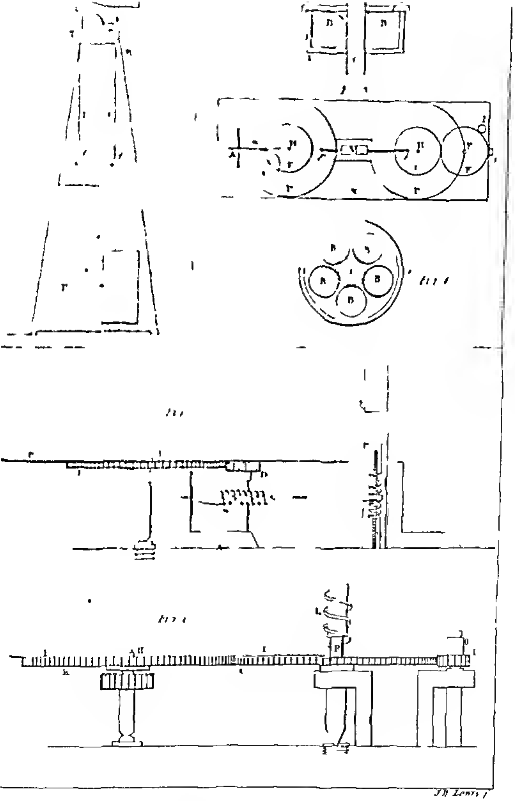
WHEWELLS ANEMOMETER











$$D = 28° 95, \text{ and } \Sigma = \frac{46\ 3}{\sin 28° 57}, = 95\ 65.$$

It appears, therefore, that during these twelve hours the real movement of the air was only 95 6 miles, from a point 29° west of south

The paper from which the above account of Dr Robinson's instrument has been abstracted is probably the best epitome of the present state of Anemometry which can be referred to by persons desirous of pursuing this interesting subject

T. A L

(See article 'Weather,' in the last volume.)

ANTI-CORROSION, as applied to Iron Traversing Platforms, Gun Carriages, and outsides of Guns

44 oz. anti-corrosion 4 oz. Grant's black. 2 oz. red lead ½ gal linseed oil. $\frac{1}{12}$ pt. spirits of turpentine.	To be well mixed, and laid on immediately, as it becomes useless from its hardening into a cake

Anti-corrosion.—Quantities for Ordnance, &c, two coats

Guns pr	ft	lbs	oz	Carronades pr	lb	oz	Mortars.	lbs	oz	Bed	
32	9½	3	1	32	1	0	13 inch Sea	2	8		
24	9½	2	7	24	0	9½	10 „ „	1	1		
18	9	1	10	18	0	8	13 „ Land	0	12	2	1
							10 „ „	0	9½	1	6
							8 „ „	0	6	1	1

Iron Carriages average 4½ lbs, and Traversing Platforms 14½ lbs

The bores are lacquered with the following

36 oz Cumberland black lead 1 gal linseed oil 10 oz. red lead. 1 oz. lamp black.	To be well ground into the oil, and then boiled slowly till thoroughly incorporated

R. J N

ARTILLERY.*—This subject was only undertaken after a distinguished Officer of Artillery had declined to contribute the article, and it is given for the use of the [illegible] in explanation of the several Tables which hava been supplied [illegible] of that part of the Army, and includes *Materiel,* as well as *Personnel,* besides the constructive and scientific departments

Marine Artillery, (Armament of Ships of War,) and the *Theory of Artillery or Gunnery,* and '*Equipment,*' are explained as they occur alphabetically in separate articles

* By Major General Lewis C B R E

SECTION I.

The constituent subjects of 'Artillery' may be concisely stated as follows

ARTILLERY

- Personnel
  - Horse Artillery.
  - Rocket ditto
  - Foot ditto
  - Invalid Gunners
  - Master Gunners
- Materiel
  - Ordnance
    - Iron
      - Guns
      - *Howitzers.*
      - *Mortars*
      - Carronades
    - Brass
      - Field guns
      - Do howitzers
      - Mortars
    - Rocket
      - Field
      - *Heavy*
  - Carriages
    - Travelling
      - Field
      - *Siege*
    - Standing
      - Wood
      - Iron
    - Waggons, &c
  - *Ammunition*
    - Powder
    - Shot
    - Shells
    - Case or canister
    - Grape.
    - Spherical case
  - Stores in general.
- Instruction
  - Academical
    - Theoretical
      - Mathematics
      - Fortification
      - Gunnery
    - Languages
  - Practical
    - *Fabrication* and Construction
      - Manufacture of powder
      - Do of other laboratory stores
      - Foundry and Proof department
      - Carriage department
    - *Elementary Tactics*
      - Repository course
      - Field battery exercise
      - Gun, mortar, howitzer, and rocket practice
      - Infantry drill, and other exercises of arms

These several branches are under the control of the Master-General and Board of Ordnance, *more especially as regards the Finance and Matériel.*—The Personnel is under the immediate orders of the Master General

SECTION II

The administration of the Artillery (subject to the Master General and Board of Ordnance) is distributed among the following departments, the head quarters being at Woolwich

1. The Personnel, under a Deputy Adjutant-General.

2 The Equipment, under a Director-General of Artillery.

3 The Stores, before and after conversion, are under the control of a Principal Storekeeper

4 The construction and fabrication of Stores for the Artillery are executed by the

Laboratory Department
Carriage Department
Department of Inspector of Artillery.

5 The Theoretical branch for Cadets is under a Lieut.-Governor in charge of the Royal Military Academy

6 And the Practical Course of Instruction is given under the direction of the above named Departments, besides the most necessary practical duties taught in the Repository

Referring to the preceding heads

1 The Personnel of the Effective force forms one regiment of Royal Artillery divided into battalions and troops, according to the exigency of the Service the minimum Peace Establishment (1852) being seven troops of Horse Artillery and twelve battalions of eight companies of Foot Artillery, and the maximum force, as a War Establishment, has been equal to fourteen troops of Horse Artillery, ten battalions of ten companies of Foot Artillery, thirteen troops of Artillery Drivers, and two foreign battalions

The Non Effective force, consisting of Invalids and Master Gunners, is usually in charge of towers and batteries, the latter being Store Accountants, the situation affords a handsome retirement to the deserving non commissioned officers of the Royal Artillery

The *Distribution* of the Personnel into Horse Artillery, destined to move with Cavalry, Foot Artillery, attached to field batteries, generally acting with Infantry, and the Artillery for garrison and Colonial duties is arbitrary, and the whole is still one regiment, the men and Officers being applicable, in the course of service to all these duties at the pleasure of the Master General as circumstances may direct.

2 The Equipment of Artillery for the field, for coast defences, sieges, and the armament and defence of places, is a combination of the elements of men, matériel, and horses, necessary for those services, and is *organized* by the Department of the Director General of Artillery Under his control, batteries are equipped for the field, either for

Horse Artillery.
Rocket Artillery
Field Foot Artillery
Mountain Artillery
Artillery of Reserve or Position

And the Equipments of Heavy Artillery are for

Siege Artillery
Artillery for Coast Defences.
Artillery for the Armament of Places

SECTION III.

The application and proportion of Artillery to

Field and Positions . . . . Sieges . . . . Armament of Places, and Coast Defences	See 'Composition of Batteries,' Table I, and 'Equipment.'

As there is no regulated or fixed principle in the application of *Artillery* to the several services before mentioned, and as the question interests every branch of the British Army, the following data are given as the probable basis for the armament of batteries.

SECTION IV.

Artillery, applicable to the field, consists of

Horse Artillery Batteries.
Field Foot " "
Mountain " "
Rocket " "
and Artillery of Reserve or Position

1. The batteries of *Horse Artillery* are usually composed of 6-pounder brass guns and 12-pounder howitzers in batteries of six pieces, as best adapted to move with Cavalry. See *Tables* F. I.

2 The armament of the *Field Foot Artillery* attached to the Infantry Corps, when the roads are tolerably practicable, are now formed of 9-pounder brass guns and 24-pounder brass howitzers. (See *Tables* F. I.) But as the difficulties of moving artillery increase, so must the calibre of the ordnance be *reduced*. The field *batteries in the early part of the* Peninsular War consisted of 3 and 6-pounder brass guns, and of 5½" and 4⅖" howitzers: at the conclusion, 9 pounder guns were used.

3 The *Mountain Artillery* is usually limited to 3 pounder brass guns, and 4⅖" howitzers, conveyed on the backs of mules: the difficulty of transport renders it convenient to compose these batteries of three guns and one howitzer, as the ordnance

carriage and ammunition have to be fixed on pack saddles See Tables F and I, 'Carriage,' Pl XXIX, and 'Equipment'

If the animals for the conveyance of Mountain Artillery are not well accustomed to carry weights on their backs, and used to mountain roads, the application of this branch of Field Artillery is very difficult

Rocket Artillery for the Field seems more applicable to countries without roads than Mountain Artillery, and also where they are much intersected by rivers, and in marshy or boggy districts, as well as for Advance Guards Hitherto, their practical effect has not been satisfactory See Table J

Artillery of Position or *Reserve* may be composed of 9 and 12 pounder brass guns, 24 and 32 pounder brass howitzers, or the 18 pounder iron gun, with an 8 inch iron howitzer if of brass, the batteries consist of six pieces, if of iron, of four only This description of heavy Field Artillery, in *offensive* operations, becomes 'Artillery of Reserve,' to be brought forward in critical periods of attack, or to insure success when the adverse forces begin to waver, and it is peculiarly adapted to the attack of posts and villages In *defensive* operations it may be termed 'Artillery of Position,' for the occupation of the prominent features in the field of battle, and commanding ground, securing the position by its superior fire See Tables E F I

The proportion of Field Artillery to an army is generally regulated by the description of the country in which the army is to act, and the means of transport, but these should rather decide the *nature* of the ordnance to be employed than the *quantity*, considering the vast resources of Great Britain With the Anglo Portuguese army in the Peninsula, the proportion of Artillery was as one to every thousand, and with the army of occupation in France, it was as three to every thousand men Napoleon preferred two to every thousand, with a large proportion of ammunition, and this rule seems to be admitted in modern armies

But the proportion of two pieces of ordnance for every thousand Infantry may be found better suited to our Service, considering how much the perfection of the Infantry force diminishes the quantity of Artillery necessary for an army

Therefore, taking an army destined for the field as 60 000—of which 50 000 is Infantry—7500 Cavalry, and about 2500 Artillery, the maximum number of pieces of artillery will be 100 in the proportion of

5 batteries of Horse Artillery, or 30 pieces for 5 brigades of Cavalry
9 batteries of Field Artillery, or 54 pieces for 8 divisions of Infantry
3 batteries of Reserve or Position, 16 pieces for the whole force *

Whether four, six, or eight pieces shall be the strength of the batteries, is generally a Professional or Artillery question, but its consisting of six does not appear to be imperatively necessary

It would seem desirable to establish as a principle, that the Field Foot Artillery attached to Infantry should not possess the mobility of Horse Artillery, and that the latter should not have the power of the former, by being armed with pieces of heavy calibre, as the efficiency of Horse Artillery depends upon the facility of moving and supporting Cavalry.

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* If there is an excess in the proportion of Artillery to the rest of the army or corps it should form part of the Reserve Artillery so as not to impede the movement of the troops and be available for the points most required

SECTION V.

HEAVY ARTILLERY

1 *Application of Artillery to Sieges.*—In the consideration of this subject also, the same two important points have to be decided—the nature of the ordnance to be employed, and the quantity. Adverting to the several sieges during the last wars, and the suggestions offered on the experience obtained from those events, the following inference is drawn as to the nature of Artillery necessary for a siege operation

[illegible] ORDNANCE.

[illegible] used for direct fire and breaching

That the 8 inch iron howitzer, with the 24 pounder iron gun, is [illegible] enfilade fire, as well as for the demolition of parapets and exposed scarps when placed in the first parallel

And that the 10 inch and 8 inch brass mortar be adopted for vertical fire, whether use[illegible] bombardment and the destruction of the magazines and platforms, or ultima[illegible] known in our Service

[illegible] the Artillery necessary, [illegible]

Although the 12 and 18 pounder iron guns are still among [illegible] scriptions of ordnance for the attack of places (see Table E), experience does not justify their use, except in cases where none other can be obtained; and as Sir John Jones, in his 'Journals of Sieges,' observes, "It is neither vertical, ricochet, nor direct fire alone, but a judicious combination of the three which will prove irresistible," and hence the

24 pounder gun for direct fire,
8 inch howitzer for ricochet, and
[illegible] mortar for vertical,
[illegible] those objects

QUANTITY OF ORDNANCE

The quantity of ordnance necessary is equally important in the attack of places There is a considerable difference in the authorities hitherto given of the number of pieces of artillery required, and the experience obtained in the reduction of fortresses rather shews that the quantity used was guided by expediency and the accidental resources of the moment

The following proportion has been adopted (by a Committee of Artillery Officers in 1819, see 'Equipment') as a siege equipment or battering train, and 100 pieces of heavy ordnance is given as the basis for all future siege operations

Iron ..	24 pounder guns	40 pieces	100
	12 „ „	20 „	
	Howitzers	15 „	
	Mortars	25 „	
[illegible]	[illegible]	20 „	40

[illegible] meet the sanction of the Duke [illegible] all number of howitzers, the quantity recommended does no[illegible] er to divide for inferior attacks, and it is questionable if the number is adequate as a maximum proportion

It is suggested therefore to establish a minimum quantity for the smallest siege operation

Lieut General Sir J Burgoyne, in the article 'Attack,' considers 25 pieces of heavy ordnance as the minimum battering train to belong to an army for the reduction of forts

It is conceived that 30 pieces of heavy ordnance with a proportion of brass mortars as a small battering train for an Artillery siege equipment, should be considered as the minimum quantity, in the proportion of

Iron ..	24 pounder guns . . .	15, or ½	30
	8 in howitzers . . .	10, or ⅓	
	10 mortars .	5, or ⅙	
	+		+
Brass	8 in mortar .	5, or ½	10.
	5½ „ .	5, or ½	

See 'Construction' of Artillery, Sect VI

This minimum siege equipment it will be found more convenient to double, triple or quadruple, than to divide the larger proportion of 100 pieces of heavy ordnance for the attack of fortresses of second and third or fourth orders

Sir J Jones proposes in his work on 'Sieges,'

Iron ..	24 pounders,	40	106 pieces of heavy artillery
	18 pounders or heavy howitzers	20	
	Mortars	46	

The 'Aide Mémoire à l'usage des Officiers d'Artillerie,' (edition of 1844) gives the following as a siege equipment

Brass	24 pounder guns	40	162 guns of heavy artillery
	16 „ „	40	
	8 in howitzers (22$^{\text{cm}}$)	40	
	10 in mortars (27$^{\text{cm}}$)	15	
	8 in „ (22$^{\text{cm}}$)	15	
	Pierriers	12	

And in the same work the following examples are detailed of different siege equipments

As proposed by	Pieces of Ordnance	In the proportion of, per 100			
		Guns	Howitzers	Mortars	Pierriers
Vauban	160	70	—	15	15
Bousmard .	168	50	18	22	10
Durtubie .	207	62	12	18	8
Dupuget	200	65	12	18	5
Gassendi	160	62	15	15	8
Austrian Equipment	178	45	13	35	7
Prussian ,	142	60	15	20	5

It appears likewise in Jones's 'Sieges,' that the undermentioned pieces of artillery were in battery at the attacks of the following places by the British Army, upon

	Guns Iron		Howitz Iron		Carron	Mortars Iron		Field Ordnance
	24 prs	18 prs	5½ in.	8 in	8 in	10 in	13 in	Brass pieces
Ciudad Rodrigo	23	4	—	—	—	—	—	2
Third siege of Badajos	16	20	16	—	—	—	—	4
St Sebastian	30	6	—	7	4	15	1	—

And in the 'Aide Mémoire d'Artillerie,' the following were in battery in the French sieges in Spain:

		Number of Pieces of Ordnance	In the proportion of, per 100.			
			Guns.	Howitzers.	Mortars.	Pierriers.
Mequinenza	in 1810	18	55	45		—
Ciudad Rodrigo	„ 1810	50	58	16	22	4
Almeida	„ 1810	67	62	18	13	7
Tortosa	„ 1810	50	40	60	—	—
Lerida	„ 1810	40	6	15	15	—
Tarragona	„ 1811	66	—	—	—	—
Badajoz	„ 1811	54	62	23	15	—

These examples are to be taken only as matters of fact, of what has been effected under the then existing circumstances and the resources of the French and British Armies, both distant from their several depôts; but it is the discrepancy of the several propositions given in the authorities before quoted which suggests the proportion herein advocated, of having as before stated,

24-pounder guns [illegible]ths
8-inch howitzers [illegible]ths.
10-inch mortars [illegible]th

And which, however, corresponds nearly with the latest siege equipages recommended by the French Officers in 1844, more particularly in the introduction of the large proportion of 8-inch howitzers; and Sir John Jones, in his 'Journals of Sieges,' Note 29, observes, "the recent improvements in the 8-inch and 10-inch howitzers will naturally, in future sieges, be made to supplant most of the guns hitherto used for enfilading."*

This arrangement combines the advantages of effect and simplicity, as likewise of economy, in the application of three descriptions only of heavy ordnance to the attack of places, and affords, by adopting a minimum quantity (30) for siege equipments, much convenience in transport, when embarked for any operations of an Army not specifically arranged beforehand, but presumed on the probable wants of a campaign.

The scheme of adopting small siege equipments instead of the maximum of the several propositions of

100 of the Committee of Royal Artillery,
100 of Sir John May, Royal Artillery,
106 of Sir John Jones, Royal Engineers,
162 of French Artillery Officers,
or 200 of several authors,

is left for consideration; but the disuse of 12 and 18-pounder guns is a simple question of calculation, the effects of these, as to time, being in the experiments at Metz, in 1834, in the inverse ratio of the weight of shot, and the effect calculated for the destruction of the parapets and traverses may be considered in the inverse ratio of the cubes of the diameter of the shot or shell of the

$$\left.\begin{array}{r} \text{8-inch howitzer} \\ \text{24-pounder gun} \\ \text{18 „} \\ \text{and 12 „} \end{array}\right\}\text{Iron}$$

* See 'Siege Operations in India,' vol. ii.

And whether it is a question of time, effect, or economy of transport, this proposition for Artillery for sieges, consisting of

$$\text{Maximum Equipment}\left\{\begin{array}{l} 120\left\{\begin{array}{lr} 60 \text{ — 24 pounder guns} & \text{. or, } 4 \times 15 \\ 40 \text{ — 8 in howitzers} & \text{. . „ } 4 \times 10 \\ 20 \text{ — 10 in mortars} & \text{. } 4 \times 5 \end{array}\right\}30 \\ \overline{120} \text{ and} \\ + \quad 40 \text{ — Small brass mortars . „ } 4 \times 10 \quad \overset{+}{10} \\ \underset{160}{=} \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad \underset{40}{=} \end{array}\right\}\text{Minimum Equipment}$$

obviously embraces either part or the whole of these advantages

It is assumed that a corresponding Engineer Equipment will accompany it, and not with the expectation of reducing a place with artillery alone

In the 'Application of Artillery to the Field,' there is a proposition for reducing small posts by means of Artillery of Reserve, and this, with what other proportion of Field Artillery may be attached to the besieging army, will serve to arm the works constructed to protect the flanks of the parallels, and be useful against sorties

2 *Coast Defences* —The arrangement best suited for the armament of maritime places and batteries, for the protection of harbours, roadsteads, rivers, and coasts, is the combination of the 8 inch gun of 65 cwt, 56 pr, 32 pr long iron gun, 13 inch iron mortar, and 68 pounder iron gun, for all positions, and none under these calibres should, it is conceived, be mounted in coast defences, to contend with the present armament of ships of war

It appears that the relative importance of Artillery for Coast Defences in these suggestions is—

The 8 inch gun
32 pounder gun
13 inch mortar
56 pounder gun

The application is more fully explained in the article 'Defence of Coasts'

3 *The Application of Artillery to the Defence of Places* —There does not appear to be any rule in our Service for the armaments of forts and fortresses In the French Service, by their latest regulations on this head it is directed that the fortified places should consist of three classes, according to their relative importance, and the Artillery necessary is divided into two portions, the one being appropriated for the immediate security of the place, and the other that which is necessary to sustain a siege the former is always mounted in battery, and the latter placed in store

The quantity necessary for the immediate security of the place is calculated at 10 pieces per bastion, which provides for the armament of the salients and flank defences, as well as for the emplacement of the heavy mortars, but that requisite to sustain a siege must depend on the extent of the works generally, and is determined from the best and latest authorities thus fortresses of the

				S =
First class,	consisting of	10 sides and upwards to the right line,	require	110 pieces
Second class,	„	6 to 10 sides, of 180 toises front,	„	70 „
Third class,	„	4 to 5 sides, of 150 toises front,	„	30 „

in addition to the 10 per bastion

The French authors adopt the following mode of expressing the total number (x) of Artillery necessary for a fortress, on having the number of bastions (m) and the value of S, as given above

$\overline{m \times 10} + S = x$. S representing the quantity for the front of attack; thus, supposing the octagon the work to be armed, the quantity required will be $\overline{8 \times 10} + 70 = 150$ pieces

The proportion of Artillery is usually $\frac{5}{10}$ of heavy guns,
$\frac{1}{10}$ „ howitzers,
$\frac{3}{10}$ „ mortars,
$\frac{1}{10}$ „ field pieces

The nature and *disposition* of *these being regulated by the previous arrangement* explained of first providing for the immediate security, and secondly, the Artillery necessary to sustain a *siege*

For the first it is suggested that the armament might advantageously to our Service consist of

8 inch gun of 65 cwt., and 32 pounder guns for the salient angles of the bastion, mounted on traversing platforms

24-pounder guns for the flank defences, on ground platforms

10 inch howitzers to the salient angles of ravelins, *en barbette*

13 inch mortars in the bastions, or curtains, for vertical fire *

This Artillery for Immediate Defence will be used likewise during the early period of attack, the number necessary, as above stated, being ten pieces per bastion

That necessary to sustain a siege, in addition *to the* above, should consist, *it is* conceived, principally of 18 pounder long Iron guns, on travelling carriages,
6½ howitzers (Dundas) ditto,
8 inch mortars,

These being in store previous to the investment

As an example to explain the quantity and nature of Artillery necessary for an octagon under both *emergencies*, in the proportion of $\frac{5}{10}$, $\frac{1}{10}$, $\frac{3}{10}$, and $\frac{1}{10}$, the following is given

Nature of Work.	Guns			Howitzers		Mortars			Field pieces	Total
	a	*c*	*f*	*b*	*g*	*d*	*h*	*i*	*e*	
Octagon	pr 32	pr 24	pr 18	in 10	in 6½	in 13	in 8	in 5½	Brass	
For Immediate Security	8	32	—	8	—	24	—	—	8	80
To sustain a Siege	—	8	27	—	7	—	11	10	7	70
	8	40	27	8	7	21	11	10	15	150
	75			15		45			15	

Application of the Artillery to the Defence

a To be mounted on salient angles of all bastions of enceinte, those of the fronts attacked being brought, after the first period, to the curtains of collateral fronts

b To be mounted in salients of ravelins, those of the fronts attacked being removed to angles of the shoulder of the collateral bastions

c For the flank defences, those of the fronts attacked being *reinforced* at the second period of defence

d To be divided off to the several bastions

e In the outworks and for sorties

f For the second period of defence, and armament of the faces of the fronts of attack.

g Ditto

h For the outworks at the second period of defence

i For the covert way at ditto

* Probably the collateral bastions will be found most convenient for the heavy vertical fire

In the event of the fortress having an interior elevated line of works, or cavaliers, commanding the surrounding country, the 68 pounder and 56 pounder guns are recommended particularly for the early period of defence.

In maritime places, the artillery for the sea faces will be regulated by the rules providing for the armament of coast defences.

The selection of artillery for the defence of fortresses is not based upon the principle which guided that proposed for the attack, the latter having in consideration the difficulty of transport, which in the former is of minor importance. Hence the 13 inch mortars, 10 inch howitzers, and 32 pounder guns are proposed especially for the early period of defence, and the 24 pounder guns for the flank defence, as combining calibre with facility of working the pieces.

For the second period of defence, the 18 pounder guns and $6\frac{1}{2}$ howitzers are selected, their mobility being of some consequence at that period, and the shot or shell of those pieces being quite equal to penetrate the newly formed parapets of the besiegers.

SECTION VI.

CONSTRUCTION OF ARTILLERY.

Some remarks are now offered with the preceding observations on Artillery, and with reference to the Tables and drawings explaining the dimensions, weights, and ranges of iron and brass ordnance for Land Service.

The Tables A. B. C. do not correspond precisely with what has been suggested as applicable in the preceding part of this article to the different services detailed for the field, for sieges, defences of coasts and harbours, and for the armament of places; as those propositions are founded upon the improvement of artillery, which implies the abandonment of a large proportion formerly in use.

For example: At an early period the short and small calibre iron guns were introduced for the convenience of the Navy, such as the 6, 9, and 12 pounder guns of various weights. For the same purpose the carronades were brought into the Service, from the 12 to the 68 pounder; they were generally adopted for Land and Sea uses; and at the close of the war, a species of ordnance, combining the gun and carronade, was introduced by Sir William Congreve for the armament of ships. These varieties are nearly all set aside in the British Navy, and it is armed generally with one calibre*—the 32 pounder, of different lengths and weights, adapted to the size of the vessel; thereby insuring an effective gun, as well as establishing uniformity, and preventing confusion in serving the ammunition. The larger vessels, from the frigates upwards, have a proportion (about $\frac{1}{10}$th) of the 8 inch gun, for firing shells or hollow shot.

As one department (that of Artillery) supplies all the Ordnance, whether for the Land or the Sea Services, these changes throw a great quantity into store; and they are used as circumstances require.

Adverting to the construction of artillery and the above mentioned variety, it would seem desirable to establish for the *Land Service* one construction peculiarly suited by its calibre † so that the piece shall be most perfect of its kind in respect to its range and weight; and the terms 'light,' 'medium,' and 'heavy,' should be obsolete, this distinction being unknown to other Services, except those in which our system has been copied. In making a selection amongst pieces of different

* See Equipment, Naval.

† Colonel Dundas observes, it is a question whether, in respect to General Bloomfield's construction, any other form is better.

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The nature and disposition of these being regulated by the previous arrangement explained, of first providing for the immediate security, and secondly, the Artillery necessary to sustain a siege

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	8	40	27	8	7	24	11	10	15	150
	75			15		45			15	

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As one department (that of Artillery) supplies all the Ordnance whether for the Land or the Sea Services, these changes throw a great quantity into store, and they are used as circumstances require

Adverting to the construction of artillery and the above mentioned variety, it would seem desirable to establish for the *Land Service* one construction peculiarly suited by its calibre,† so that the piece shall be most perfect of its kind in respect to its range and weight, and the terms 'light,' 'medium, and 'heavy' should be obsolete, this distinction being unknown to other Services, except those in which our system has been copied In making a selection amongst pieces of different

* See Equipment Naval'

† Colonel Dundas observes it is a question whether in respect to General Bloomfield s construction, any other form is better

calibre, the decision will be much influenced by the weight of ammunition thereby entailed, but when the question lies amongst ordnance of the same calibre and of different weights, there can be no economy in, no plea for, dragging along a gun of imperfect and unsatisfactory character

The following observations refer to construction, first, as regards the 6⅓ howitzer, lately introduced by Colonel Dundas into the Service, of 10 calibres and 17 cwt. It would be desirable to have as a corresponding piece the 6⅓ mortar of brass, and to consider the 4⅖ mortar as too small and inefficient, the smallest in the French Artillery being 15 centimetres, or about 6 inches

Secondly. Difficulties occur in siege batteries when the howitzer is used, in consequence of the muzzle not entering into the throat of the embrazure, the cheeks are then blown away, and the men exposed after a few rounds are fired Two expedients might be adopted to remedy this inconvenience, either to provide for mounting the 8 inch howitzer on garrison carriages, or to lengthen the piece to eight calibres corresponding with the 68 pounder carronade, but this last plan would involve difficulties in building a travelling carriage of sufficient strength

Thirdly If the 10 inch mortar is considered sufficient for siege operations, and the maximum calibre for the mortar in the French Service is 27 centimetres (about 10 63 inches), the construction of a 13 inch Land Service mortar of range equal to that of the 56 pounder gun—3500 yards—may be worthy of consideration for coast defences, and the armament of places, as the question of transport is not of importance in such cases, or the use of the Sea Service mortar

The following pieces of artillery may be considered as sufficient to meet all the wants of the Land Service, notwithstanding the numbers yet retained in the Service, as a matter probably of convenience and economy, as given in Tables A B C

Guns	*a.*	68	pounder and 8 in gun	Iron
	a b	56	" " "	Iron
	a b	32	" " "	Iron
	b c	24	" " "	Iron
	b c	18	" " "	Iron
	e	12	" " "	Brass
	d	9	" " "	Brass
	d	6	" " "	Brass
	f	3	" " "	Brass
Howitzers	*b*	10	inch	Iron
	a c	8	"	Brass
	b c	6⅓	"	Brass
	d	5½	" and 24 pounder	Brass
	d f	4⅖	" and 12 "	Brass
Mortars	*a b*	13	"	Iron.
	b c	10	"	Iron.
	b	8	"	Iron.
	b c	6⅓	"	Brass
	c	5½	"	Brass

Application:
- *a* Sea defences
- *b* The armament of places.
- *c* Sieges
- *d* Field Artillery
- *e* Ditto of reserve
- *f* Ditto for mountains

It will be perceived, that in the British Service all the light (or field) artillery is at present constructed of brass, and that all the heavy is of iron

For the Theory of Construction, see 'Gunnery,' and some valuable observations in Jones's Sieges (Note 17, vol. i. second edition) G G L.

ARTILLERY TABLES

REMARKS AND NOTES

TABLES A B C —Very few systematic constructions of Ordnance being extant and the varieties amongst those for guns of the same calibre being notorious the plan of giving one General Table of Dimensions for all Ordnance now in the Service has been adopted taking care as much as possible, to represent like parts in all by the same letters

For the execution of the very laborious task of filling in these Tables from actual admeasurement, we are indebted to the Inspector of Royal Artillery

e A With reference to the forms of 'Bored up' guns which at present hold an intermediate place between the 'Ordinary' and 'Millar' constructions the practice is variable, as the operation itself was experimental Generally speaking guns of 'ordinary' proportions were placed in the lathe and modified somewhat to Millar's shapes by the second reinforce being sloped to nearly a continuation of the chase, and by the moulding beads being turned off to flat fillets In some instances metal has been taken off inside and outside whilst in others the bore only has been increased and that even by two calibres

B In Carronades the 'length of the bore' does not include the cup at the muzzle

B In mortars the bore is divided into two parts—chase and chamber; the chase extends from the *face of the piece to the seat of the bottom of the shell; the chamber comprises the remainder of the* conic frustum occupied by the charge, but in the Tables length of bore is given as from the face of the mortar to the bottom of the chamber

D —This Table was specially applied for as an authority in consequence of the variation of calibres of the same denomination; thus there are no less than five different calibres for the 32 pounder as now in the Service —*Vide* Griffiths Ed 2 p 61

F —This has been circulated as an order by the Master General and Board Two columns, for calibre and point blank have been added for this work

F —Compiled from the best authorities as far as materials could be obtained

J —This gives all that is considered necessary for general purposes

ARTILLERY TABLE A.

CONSTRUCTION OF

Service	Construction		Length		Weight	AB	AC	AD	AE	AF	FG	AH	AI	AJ	AK	A
			′	″	cwt	″	″	″	″	″	″	″	″	″	″	″
[illegible]	[illegible]	10 in gun	9	4	86	72 4	44 8	58	99 3	112	109 33	16 02	5 32	[illegible]	109 5	37 13
										130	111 4	16 8	5 07	63	127 17	[illegible]

ARTILLERY TABLE B.

CONSTRUCTION OF

Service	Construction		Length		Weight	AB	AC	AD	AE	AF	FG	AH	AI	AJ	AK	A
												″	″	″	″	″
											75	9 55	2 50	—	105 725	15 7
											73	7 75	2	40 9	82 41	15 46
											95	8 81	2 15	—	70 53	15 9
											291	8 09	2 02	21 63	63 4	14 6
											229	8 5	1 93	—	105 51	16 5
L	O	14									—	—	—	—	—	—
L	O	13	8	0	27	—	—	—	—	—	—	—	—	—	—	—
L	O	9	8	6	28½	—	—	—	—	—	—	—	—	—	—	—
L	O	9	7	6	26	—	—	—	—	—	—	—	—	—	—	—
L	O	9	7	0	23	—	—	—	—	—	—	—	—	—	—	—
L	O	9	8	6	17	—	—	—	—	—	—	—	—	—	—	—
L	O	6	8	6	21	—	—	—	—	—	—	—	—	—	—	—
L	O	6	8	0	22	—	—	—	—	—	—	—	—	—	—	—
L	O	6	7	6	21	—	—	—	—	—	—	—	—	—	—	—
L	O	6	7	0	20	—	—	—	—	—	—	—	—	—	—	—
L	O	6	6	6	18	—	—	—	—	—	—	—	—	—	—	—
L	O	6	6	0	17	20 57	30 8	21 7	61 25	72	56 97	6 75	1 42	—	70 6	15
L	O	6	5	11	11											
S	O	32 pr carronade	3	11½	17	2 9	15 9	20 2	41 68	47 71	42 6	15 6	21 34	42 03	42 35	17 4
S	O	24	3	7½	13	2 63	14 47	18 4	37 75	43 4	38 76	14 58	19 42	38 08	39 72	13 6
S	O	18	3	9¼	10	2 4	13 05	16 58	34 07	39 23	36 34	13 05	17 5	34 62	35 05	14 3
S	O	12	2	8¼	6½	2 24	11 44	14 62	27 64	33 36	23 71	11 19	15 40	27 98	29 34	12 6
L	M	10 in howitzer	5	0	43	17 68	25 455	30	51 1	66	57 21	12	2 04	36	58 21	23 4
L	M	8	4	0	22	14 24	20 35	24	41	49	45 45	9 6	2 71	29	46 43	19 5
L	O	5½	3	4½	15	—	17 45	20 39	37 9	40 76	32 75	7 84	2 35	21 48	39 5	17 5
S	O	13 in mortar	4	4	100	11 37	11 5	23 62	36 01	43 73	2 78	39 01	—	—	—	—
L	O	13	3	3½	36	9 75	7 9	14 95	16 9	37 6	2	—	—	—	—	—
S	O	10	3	9	50	8 75	11 3	19 32	76	42 5	2 5	31 25	—	—	—	—
L	O	10	2	7½	18	7 5	8 125	13 195	13	26 25	1 875	—	—	—	—	—
L	O	8	2	1½	9	6	6 3	10 5	11	21	1 5	—	—	—	—	—

RDNANCE —IRON. See Artillery Plates I III IV.

								Trunnions			Thickness of Metal			Chamber			Remarks
DIAMETERS																	
[illegible]	C.	D	F	F	I	J	K	Diam	Length	Span	At Breech	At Muzzle	Calibre	Length	Diameters		
	″	″		″	″	″	″	″	′	″	″	″	″	′	′	″	
5	—	17 51	18 8	11 86	22 43	—	15 93	6 41	6 6	31 325	7 26	8 72	6 41 6 41	—	—	—	
										83 44	5 34	8 43	6 3	—	—		

Remarks: M Millar; M′ Monk; O Ordinary; I Intermediate between M and O; being Bored up guns. S Sea Service; L Land Service; S L Both.

RDNANCE —IRON See Artillery Plates I II

								Trunnions			Thickness of Metal			Chamber			Remarks
DIAMETERS																	
[illegible]	C	D	F	F	I	J	K	Diam	Length	Span	At Breech	At Muzzle	Calibre	Length	Diameters		
	″	′		″	′		″	′				″	′	″		″	
	—	13 4	11 565	10 8	19 68	—	14 25	5·29	5 43	26 69	6 37	8 75	5 292 5 292	—	—	—	
1 51	—	13 2	9 15														
1 9	—	13 3	9 31														
[illegible]	—	12 46	8 93														
[illegible]	—	13 9	10 39														
—	—	—	—	—	—	—	—	—	—	—	—	—	4 62	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	—	4 62	—	—	—	
			—	—	—	—	—	—	—	—	—	—	4 8	—	—	—	
							—	—	—	—	—	—	4 2	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	—	4 8	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	—	4 2	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	—	5 66	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	—	5 66	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	—	5 66	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	—	5 66	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	—	—	3 66	—	—	—	
1	—	11 63	8 7	3 6	13 06	—	14 46	3 [illegible]	3 05	18 8	8 09	3 44	5 66	—	—	—	
1 6	—	—					[illegible]	[illegible]	—	8	8 33	3 3	5 66 6·24	5·04	5 63	3 63	
											4 54	5 8	5 81	4 44	5 81	0·01	
											4 3	3 34	5 16	1·2	4 1	1 1	
											3 [illegible]	3·05	4 87	5·63	4 06	4·06	
											6·26	3 43	10	11·24	14	[illegible]	
											4·9	3 33	3	9·5	5	8 11	
											5 4	3 95	5·64	5 1	5 61	3·61	
—	—	34·93	33 [illegible]	34 33 34·93	34 33	33 [illegible]	—	11 3	8 83	32 81	—	18 [illegible]	18	4 4	9 [illegible]	[illegible] 31	
—	—	34 33	—	—	—	—	—	9 [illegible]	[illegible] 32	33 [illegible]	—	3·83	13	11·6	13 5	8 4	
					(6	m)											
—	—	26·92	[illegible]	[illegible] 26 9	26 [illegible]	[illegible]	—	8 [illegible]	6 18	[illegible]	—	8·0	9	11 [illegible]	[illegible]	3·6	
—	—	20 36	24	[illegible]	—	—	—	8	2	30 36	—	0·91	1	8 31	9 [illegible]	3 4	
—	—	16 5	16	10	—	—	—	4	8	31 5	—	1	9	8	[illegible]	4 13	

Remarks: M Millar; M′ Monk; O Ordinary; I Intermediate between M and O; being Bored up guns. S Sea Service; L Land Service; S L Both.

Service	Construction		Length		Weight	AB	AC	AD	AE	AF	FG	AH	AI	AJ	AK	A
				"	cwt	"	"		"		"	"	"	"		"
L	O	12 pr gun (medium)	6	6	17½	21 83	34 92	39 535	70 82	78 6	74 55	6 73	1 2	——	77	13 87
L	O	9 "	5	11	13½	19 35	31 76	35 96	64 81	71 4	67 74	5 78	1 09	——	70 25	12 6
S L	O	6 (long)	7	0	12	27 1	37 33	40 47	74 43	84	80 35	5 84	1 4	——	82 74	11 33
L	O	6 " (light)	5	0	6	16 66	26 66	30 33	54 07	60	5 47	6 03	1	——	59 14	9 6
L	O	3 " (long)	6	0½	6	9 8	32 1	35	65 2	72 8	60 2	4 7	1 2	——	71 6	8 7
L	O	3 " (light)	4	6	3	13 33	21 32	24 92	43 14	48	46	4 1	1 1	——	47 24	61
L	O	3 " (colonial)	4	0	3	13 3	21 6	24 2	43	49	45 5	3 8	1 3	——	47 2	6
L	O	3 " (mountain)	3	0	2¼	10	16	18 91	32 57	36	34	3 9	64	——	35 25	61
L	O	1 (mountain)	5	0	2½	16 67	20 7	28 72	53 73	60	57 98	3 56	1	——	59 25	6 2
I	M	32-pr howitzer (Dundas)	5	3	17½	17 85	27 3	31 5	5 56	63	61 16	7 26	——	34 79	61 6	14 95
S L	M	24	4	8½	12	13 2	24 5	29 2	50 1	56 6	53 15	6 49	3 04	31 26	55 44	12 8
L	M	12 "	3	9	6½	12 2	19 87	22 7	40 2	45 2	43 11	5 75	2 13	25 2	44 29	10 2
L	O	4⅖ " (light)	1	10⅞	2¼	6 49	11 28	14 06	20 9	27 6	16 1	3 6	1 69	——	21 9	6 47
L	O	4⅖ " (Coehorn)	1	10⅞	2¾	6 3	11 27	14 15	20 85	22 6	16 1	3 52	1 69	——	21 83	6 47
L	O	5½ in mortar (Royal)	1	2⅝	1¼	2 57	4 55	8 2	10 1	10 8	11 92	13 7	13 8	14 55		(G) 7 37
L	O	4⅖ " (Coehorn)	1	0	1	2 1	3 93	4 48	8 4	9	10 13	11 8	11 9	12 49	——	(D) 6 43

ARTILLER

Return shewing the Calibre of British Ordnance, and the Maximum and Minimum Diamet

		Nature of Ordnance		ft	in	Calibre	Diam of gauges Maxim	Diam of gauges Minim	Mean diam of shot
						inches	inches.	inches	inches
1	Iron	68 pr gun	8 inch guns	9	6	8 05	7 95	7 9	7 925
2		68 do		5	8½				
3		56 do		11	0	7 65	7 51	7 45	7 48
4		32 do.		9	6	6 41	6 207	6 147	6 177
5		Do do		6	6	6 3			
6		24 do		9	6	5 823	5 629	5 381	5 6115
7		Do do		9	0	do	do	do	do
8		Do do		6	0	5 75	do.	do	do
9		18 do		9	0	5 292	5 124	5 0 4	5 099
10		Do do		6	0	5 17	do	do	do
11		12 do		9	0	4 623	4 476	4 432	4 454
12		6 do		6	0	3 668	3 568	3 532	3 55
13		10 inch howitzer				10 0	9 88	9 8	9 84
14		8 do. do				8 0	7 9	7 82	7 86
15		24 pr do				5 68	5 62	5 57	5 595
16		13 inch mortar				13 0	12 88	12 8	12 84
17		10 do do				10 0	9 88	9 8	9 84
18		8 do do				8 0	7 9	7 82	7 86
19		32 pr carronade				6 25	6 207	6 147	6 177
20		24 do. do				5 68	5 629	5 384	5 6115
21		12 do do				4 52	4 476	4 432	4 454
22	Brass	32 pr howitzer				6 3	6 207	6 147	6 177
23		24 do do. (Millar)				5 72	5 62	5 57	5 595
24		5½ inch do				5 62	do	do	do
25		12 pr do. (Millar)				4 58	4 4 6	4 432	4 454
26		4⅖ inch do				4 52	do	do	do
27		12 pr medium gun				4 623	4 34	4 365	4 323
28		9 do do				4 2	4 117	4 082	4 1
29		6 do heavy gun				3 668	3 585	3 55	3 568
30		Do light do				do	do	do	do
31		3 do heavy and light do				2 913	2 638	2 609	2 823
32		5½ inch mortar (Royal				5 62	5 67	5 57	5 595
33		4⅖ do do (Coehorn				4 52	4 4 6	4 422	4 451

DIAMETERS								Trunnions			Thickness of Metal			Chamber			Remarks
B	C.	D	F	F	I	J.	K.	Diam	Length.	Span.	At Breech	At Muzzle	Calibre.	Length	Diameters		
"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	
12 04	—	10 93	2 33	2 03	13 82	—	10 2	4 23	4 25	20	4 07	1 71	4 623	—	—	—	
11	—	9 96	7 8	7 36	12 6	—	9 6	3 87	3 87	10 21	3 67	1 37	4 2	—	—	—	M Millar.
9 73	—	9	6 33	6 73	11 35	—	2 23	3 66	2 60	16 38	2 03	1 35	3 66	—	—	—	M' Monk
8 29	—	7 33	3 84	3 51	9 61	—	7 37	2 94	2 5	14 8	2 33	95	3 66	—	—	—	O Ordinary
7 3	—	6 8	3 1	3	2 7	—	6 9	2 7	3 2	11 2	1 92	97	2 91	—	—	—	
6 3	—	3 6	4 64	4 33	7 64	—	6 01	2 36	2 33	11 2	1 98	74	2 91	—	—	—	
6 3	—	5 9	4 6	4 2	7 6	—	6	2 2	2 6	11 5	2 23	61	2 93	—	—	—	
6 33	—	3 87	4 62	4 39	7 63	—	3 2	2 32	2 36	10 93	2 33	73	2 91	—	—	—	
							"	2 21	2 3	10 1	1 25	73	2 01	—	—	—	
								4 63	4 5	22 2	4 2	1 63	6 3	10 20	6 3	3	
								4 2	4 25	19 69	3 27	1 21	5 72	7 86	5 66	4 2	S Sea Service
								2 6	2 6	17 03	2 37	1 59	4 32	6 8	4 40	3 4	L Land Service
								2 89	3 1	14 67	2 55	1 13	4 52	3 1	2 20	2 26	S L Both
								2 23	2 1	10 67	2 53	1 13	4 32	4 2	2 26	2 26	
6 8	7 8	2 13	2 45	7 82	2 43	2 35	(m) 8 26	2 2	3 3	13		7	5 62	3 2	3 45	3 1	
5 87	6 83	7 1	7 34	6 23	7 34	7 2	(m) 7 1	2 26	2 5	43 55	—	69	4 32	3 9	4 25	2 6	

BLE D.

Shot and Shell; the Minimum exhibiting the greatest Windage possible to insure accurate practice.

Remarks and Observations

Shells and hollow shot.

Bored up gun

In the shorter pieces howitzers and mortars, the windage is, for the same reason, brought to the very lowest practicable limit

Weights, Dimensions, &c of Common Shells

For Field Service		13 inch	42 inch	2 inch	2½ inch	4⅔ inch
				12 lbs	44 lbs 2 oz	7 lbs 0 oz
				88 in	5 57 in	6 43 in
				2 „		
				3 lbs.		
	Bursting charge	6¾ „	2¾ „	4¾ „	0 lbs 10 oz	0 lbs 3 oz

ARTILLERY TABLE E

Table of Pieces of Iron Ordnance which are to be used in the Armament generally of Works, Forts, Towers, and Sea Batteries

	Nature of Ordnance	Length	Calibre	Weight	Charge	Ranges P B	Ranges 2°	Ranges 5°	Ranges 8°	Ranges 12°	Recoil	How mounted	Remarks
		ft in	in	cwts	lbs	yards	yards	yards	yards	yards	feet		
1	8 inch shell gun	9 0	8·05	65	10	300	1130	1900	2400	3010	6½	Upon traversing or ground platform as required	This gun to be used with hollow shot, shells and spherical case, also common case. Useful against shipping, to command roadsteads and approaches, and it may be considered as equal in power to the heavy 32 pounder
2	8 do.	6 6½	8·05	50	8	210	1000	1600	2250	2870	8½	Ditto	Proposed as a substitute for the 68 pounder carronade for flanks and interior defences; also for commanding landing places. Ammunition as in former case
3	32 pounder gun	9 6	6·41	56	10	400	1130	1964	2335	3030	7	Ditto	The power and range of this piece of ordnance points it out as one of the best guns for distant ranges against shipping, &c. Hot shot in addition to the usual ammunition
4	32 do.	6 6	6·3	33	5	300	1050	1740	2700	2800	11½	Upon bracket carriage and ground platform	This gun is for flanks and all purposes of a shorter range. Ammunition as above, to be associated with No 3.
5	24 do	9 6 or 9 0	5·82	50 or 48	8	400	1100	1850	2210	2960	6½	Upon bracket carriage and traversing or ground platform	The range somewhat less than from a 32 pounder, but it is a useful gun, and for general purposes hardly inferior to it
6	24 do	6 0	5·75	20	2½	—	730	1780	1750	2700	9½	Ground platform	For flanks and short ranges; good gun for common and spherical case. To be associated with No. 4. Substitute for 24-pounder carronades in casemates, &c.
7	18 do.	9 0	5·29	42	6	400	2010	1773	2230	2870	6	As Nos 1, 3 and 5.	The range of this gun is considerable, and it may be useful against the approaches of boats, &c. It is fitted for the land fronts of works which may be exposed to desultory attack, and where rapid firing may be necessary
8	18 do	6 0	5·17	20½	3	—	765	1300	1780	2758	9	Ground platform	For flanks and short ranges.—To be associated with No 7
9	12 do	9 6	4·62	34	4	400	1000	1520	1910	2 68	3	Ground platform	This gun to be used as No 7. Under many circumstances it will be useful
10	6 do	6 0	3·66	17	2	300	940	1470	1660	2100	4½	Ground platform	Principally intended to be mounted on saluting batteries
11	10 inch howitzer	—	10·0	41	7	—	650	1100	1770	2410	8½	Ground platform.	These powerful pieces may be used for faces, flanks, interior defences, and against enemy's cruisers; their weight is such as to allow of their being moved from place to place as may be required
12	8 do	—	8·0	21	4	—	600	1000	1650	2000	7½	Ground platform	
13	5½ do	—	5·68	14	2	—	730	1700	1700	2175	10	Either on ground platform or dwarf traversing	A convenient piece on works to move about as necessary, and for towers of weak construction
14	13 inch mortar	—	13·0	36	9	—	Extreme range			2900	—	———	No remarks here necessary
15	10 do	—	10·0	18	4	—	Extreme range			2400	—	———	
16	8 do	—	8·0	9	2	—	Extreme range			2000	—	———	
17	56-pounder gun	11 0	7·65	97	16	—	1390	2260	2750	3350	6½	Sliding carriage recoiling on dead blocks and traversing platform	For positions requiring very distant ranges.

NOTE.—*Iron Carriages and Iron Traversing Platforms.*—The question of the suitability and efficiency of iron garrison carriages and iron traversing platforms for works of defence not liable to enfilade or direct heavy fire having been repeatedly entered into, and the trials to which they have been subjected at different times and places having given satisfactory results, it has been considered expedient to maintain the use of such carriages and platforms in the Service, and the Master General and Board concurring in the opinion expressed in a Report of a Select Committee of Artillery Officers dated 31st May 1839, that iron carriages are considered efficient for the armament of the Coast, and of Fortresses in time of peace, with due precaution that in every strong place there is a sufficient number of wooden gun carriages in store to be employed on the weaker front, or fronts, in the event of a regular attack; they direct that the proportion of iron carriages and iron traversing platforms, as compared with those of wood, be regulated accordingly in the Armament of Forts and other defensive works.

OFFICE OF ORDNANCE, 22nd January, 1844.

The columns 'Calibre' and 'P B' have been added to the official document by the Committee; the additional matter from good authority, although the ranges are higher than have been usually given of late years.

ARTILLERY TABLE F.

Table of Brass Ordnance.—Ranges and Application.

	Nature of Ordnance		Length	Calibre	Weight	Full Charge	Ranges P.B.	1°	2°	3°	4°	5°	6°	Remarks
			ft. in.	in.	cwt.	lb. oz.	yards	yards	yards	yards	yards	yards	yards	
1	12-pr. gun	medium	6 6½	4.62	18	4								Batteries of reserve and position
2	9 do.		5 11½	4.2	13½	3	300	700	1000	1200	1400			Foot batteries
3	6 do.	long or Desaguliers	7 0	3.66	19	2								
4	6 do.	light	5 0	3.66	6	1½	300	600	900	1000	1200			Horse artillery; Foot batteries. One supplied to men-of-war of all classes from 120 26 guns inclusive; also to the larger steamers
5	3 do.	long	6 0½	2.91	6	1								
6	3 do.	light	4 0	2.91	3	½								
7	3 do.	colonial	3 0	2.91	3	½								
8	3 do.	mountain	3 7½	2.91	2½	½								
9	1 do.	do.	3 0	2.01	2½	¼								
10	24-pr. howitzer	Dundas	3 3	6.3	12½	3	270		738		1110		1430*	Attached to 12-pr. batteries of reserve and position; good gun for spherical case
11	12	do.	4 9½	4.58	13	2½	200	450	600	850	1022			Attached to 9-pr. batteries, and to those of reserve and position. One supplied to men of war of all classes from 120 74 guns inclusive
12	12	do.	2 9½	4.58	6½	1½		400	600	900	1000	1110†		Attached to 6-pr. foot batteries, and horse artillery
13	4⅖	do.	Coehorn	1 10	4.53	2½	½							
14	5½	do.	mountain	1 10½	4.52	2½	½							
15	5½ inch mortar	Royal	1 2½	5.72	1½									
16	4⅖ do.	Coehorn	1 0½	4.52	[illegible]									

* 8° 1[illegible] yards
10° 1900 "
12° 2250 "
14° 2[illegible] "

† 5½° 1150 yards

ARTILLERY TABLE B

Table of Pieces of Iron Ordnance which are to be used in the Armament generally of Works, Forts, Towers and Sea Batteries

	Nature of Ordnance	Length	Calibre	Weight	Charge	Ranges P B	Ranges 2°	Ranges 5°	Ranges 8°	Ranges 12°	Recoil	How mounted	Remarks
		ft. in	in	cwts	lbs	yards	yards	yards	yards	yards	cwt		
1	8 inch shell gun	9 0	8 05	65	10	300	1190	19 0	2400	3010	6½	Upon traversing or ground platform as required	This gun to be used with hollow shot, shells and spherical case, also common case. Useful against shipping, to command roadsteads and approaches, and it may be considered as equal in power to the heavy 32 pounder
2	8 do	6 8½	8 05	50	8	210	10 0	1600	22 0	28 0	8½	Ditto	Proposed as a substitute for the 68 pounder carronade for flanks and exterior defences; also for commanding landing places. Ammunition as in former case
3	32 pounder gun	9 6	6 41	56	10	400	1150	1964	2335	3030	7	Ditto	The power and range of this piece of ordnance point it out as one of the best guns for distant ranges against shipping, &c. Hot shot in addition to the usual ammunition
4	32 do	6 6	6 3	33	5	350	1050	1740	2200	2800	11½	Upon truck carriage and ground platform	This gun is for flanks and all purposes of a shorter range. Ammunition as above; to be associated with No 3
5	24 do	9 6 or 9 0	5 82	50 or 48	8	400	1100	1850	2210	2950	8½	Upon truck carriage and traversing or ground platform	The range somewhat less than from a 32 pounder, but it is a useful gun, and for general purposes hardly inferior to it
6	24 do	6 0	5 5	20	2	—	750	1?80	1 30	2?00	9½	Ground platform	For flanks and short ranges, good gun for common and spherical case. To be associated with No 5. Substitute for 24 pounder carronades in casemates, &c
7	18 do	9 0	5 29	42	6	400	1050	1 0	2230	?6?0	6	As Nos 1, 3 and 5	The range of this gun is considerable and it may be useful against the approaches of boats, &c. It is fitted for the land fronts of works which may be exposed to desultory attack, and where rapid firing may be necessary
8	18 do	6 0	5 17	20½	3	—	?63	1300	1 80	2?50	9	Ground platform	For flanks and short ranges.—To be associated with No 7
9	12 do	9 6	4 62	31	4	400	1000	1520	1940	2 00	5	Ground platform	This gun to be used as No 7. Under many circumstances it will be useful
10	6 do	6 0	3 66	17	2	300	9?0	14 0	1880	2400	4½	Ground platform	Principally intended to be mounted on saluting batteries.
11	10 inch howitzer	—	10 0	42	7	—	650	1100	17 0	2410	9½	Ground platform	These powerful pieces may be used for faces, flanks, interior defences and against enemy's cruizers; their weight is such as to allow of their being moved from place to place as may be required
12	8 do.	—	8 0	21	4	—	600	1000	1650	2000	7½	Ground platform	
13	5½ do	—	5 62	15	3	—	730	1?00	1 00	21 5	10	Either on ground platform or dwarf traversing	A convenient piece on works to move about as necessary, and for towers of weak construction
14	13 inch mortar	—	13 0	36	9	—	Extreme range			?900	—	———	No remarks here necessary
15	10 do	—	10 0	18	4	—	Extreme range			2400	—	———	
16	8 do	—	8 0	9	2	—	Extreme range			2000	—	———	
17	56-pounder gun	11 0	? 65	97	16	—	1300	2260	2 60	3500	6½	Sliding carriage recoiling on dead blocks and traversing platform	For positions requiring very distant ranges.

NOTE —*Iron Carriages and Iron Traversing Platforms*.—The question of the suitability and efficiency of iron garrison carriages and iron traversing platforms for works of defence not liable to enfilade or direct heavy fire having been repeatedly entered into, and the trials to which they have been subjected at different times and places having given satisfactory results, it has been considered expedient to maintain the use of such carriages and platforms in the Service and the Master General and Board concurring in the opinion expressed in a Report of a Select Committee of Artillery Officers dated 31st May 1833 that iron carriages are considered efficient for the armament of the Coast, and of Fortresses in time of peace, with due precaution that in every strong place there is a sufficient number of wooden gun carriages in store to be employed on the weaker front or fronts in the event of a regular attack, —they direct that the proportion of iron carriages and iron traversing platforms, as compared with those of wood, be regulated accordingly in the Armament of Forts and other defensive works

OFFICE OF ORDNANCE, 22nd January 1844. M/31

The columns "Calibre" and "P B" have been added to the official document by the Committee; the additional matter from good authority, although the ranges are higher than have been usually given of late years

ARTILLERY TABLE F.

Table of Brass Ordnance.—Ranges and Application.

	Nature of Ordnance		Length	Calibre	Weight	Full Charge	Ranges P B	1°	2°	3°	4°	5°	6°	Remarks
			ft in	in	cwt	lbs	yards	yards	yards	yards	yards	yards	yards	
1	12 pr gun	medium	6 6½	4 62	18	4	300	700	1000	1200	1400			Batteries of reserve and position
2	9 do		5 11½	4 2	13½	3								Foot batteries
3	6 do long or Desaguliers'		7 0	3 66	12	2								
4	6 do	light	5 0	3 66	6	1½	200	600	900	1000	1280			Horse artillery; Foot batteries. One supplied to men-of war of all classes from 120-26 guns inclusive; also to the larger steamers
5	3 do	long	6 0½	2 91	6	1								
6	3 do	light	4 0	2 91	3	¾								
7	3 do	colonial	4 0	2 95	3	¾								
8	3 do	mountain	3 7½	2 91	2¼	½								
9	1 do	do	3 0	2 01	2¼	¼								
10	32 pr howitzer	Dundas	6 3	6 2	17½	3	370		735		1110		1430*	Attached to 12 pr batteries of reserve and position; good gun for spherical case
11	24 do	Millar	4 8½	5 72	12	2½	200	450	650	850	1025			Attached to 9 pr batteries, and to those of reserve and position. One supplied to men of war of all classes from 120-70 guns inclusive
12	12 do	Millar	3 9 7/10	4 58	6½	1¼		400	600	800	1000	1110†		Attached to 6-pr foot batteries, and horse artillery
13	4⅖ do	Coehorn	1 10¾	4 52	2½	½								
14	4⅖ do	mountain	1 10¾	4 58	2½	½								
15	5½ inch mortar	Royal	1 2½	5 62	1¼									
16	4⅖ do	Coehorn	1 0¾	4 52	1									

* 5° 1770 yards
10° 1990 „
12° 2290 „
14° 2386 „

† 5½° 1150 yards

ARTILLERY TABLE G

Depression of Guns mounted upon Garrison Carriages

Carriages, Garrison			Calibre	Weight	Degrees	With elevating screw alone, Degrees
Gun, upon wood coin	Wood carriage		8 in	65 cwt	3½	
			32 pr	56 „	5	
			24	50 „	3	
			18	42 „	3½	
			12	34 „	2	
	Iron carriage		32 pr	56 cwt	4	
			24	50 „	4	
			18	42 „	4	
			12	34 „	3½	
Carronade, *block trail*	Wood carriage, upon a wood coin		68 pr		9	4½
			42		7½	2
			32		7	2
			24		6½	2
			18		6	
			12		5	
	Iron upon depression block and elevating screw		24 pr		14	3½
			18		15	0½
			12		16	2
Howitzer, wood upon the head of elevating screw and iron swing bed			10 inch iron		1 *	
			8 „		7½	

N B —Several of the gun and carronade carriages at Gibraltar and St Helena are mounted in a peculiar way, to give about 25 degrees depression

The preceding, Table G, gives the depressions with the present construction the following Table H shows what may be given, assuming the height of the genouillere at 2 ft 3 in or 2 ft 4 in so that all garrison guns may fire conveniently over it, and corresponding changes are contemplated in the construction of garrison carriages *so as to bring all guns to an uniform maximum Elevation of 10°, and a Depression of 2°*,—this last as supposed to be sufficient for ordinary purposes, and all to be obtainable from the common coin But when as in case of towers flanks of bastions, &c , &c depressions to 6½° or 7° are often necessary, so as to be able to take up ground beyond the effective range of musketry, the additional coin must be used *The carriage would possibly admit of more than the above, but the experiment would* be hazardous without cap-squares

The greatest depression that can be allowed with safety to 18 24 32 pr garrison carriages (which are all without cap squares) wood or iron is 7° on traversing platforms and 6½° on ground platforms

All elevations and depressions in Tables G and H refer to the horizon and not to the platform

* Cap-squares are provided to effect this In the Plate of the carriage for this piece it is given as with iron trunnion boxes since superseded by cap squares See Carriage Pl 11

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ARTILLERY TABLE II.

A Table shewing the Height, Elevation, and Depression of the following Ordnance, mounted upon Common Garrison Carriages.

			Elevation upon			Depression			Height.		
			Stool bed laid on axle-tree	Stool bed	Block of carriage	With elevating screw and depressing block	With elevating screw	With common coin	From platform to axis of gun	Under swell of muzzle at greatest depression	Under swell of muzzle at 8 degrees depression
			°	°	°	°	°	°	ft. in.	ft. in.	ft. in.
Carriages. Guns.	Wood.	8 in. of 65 cwt. and 9 ft.	16	10	–	–	–	2	3 5½	–	2 2½
		32 pr. 56 „ 9½ „	16	10	–	–	–	2	3 6	–	2 2½
		24 50 „ 9½ „	16½	10	–	–	–	2	3 5½	–	2 2½
		18 42 „ 9 „	18	10	–	–	–	2	3 4½	–	2 2½
		12 34 „ 9 „	18½	10	–	–	–	2	3 4	–	2 2½
	Iron.	32 pr. of 56 cwt. and 9½ ft.	–	9½	–	–	–	2½	3 6	–	2 7½
		24 50 „ 9½	–	10	–	–	–	2	3 5½	–	2 7½
		18 42 „ 9 „	–	10	–	–	–	2	3 2	–	2 4½
		12 34 „ 9 „	–	10	–	–	–	2	3 1½	–	2 4½
Howit., wood		10 in. iron	–	13	–	–	1	–	3 5	–	2 5½
		8 „	–	16	–	–	7½	–	3 3½	–	2 6
Carronade	Wood.	68 pr.	–	–	14		5½	–	3 7½	2 8¼	2 9½
		42	–	–	14½	13½	3½	–	3 3½	2 3½	2 7
		32	–	–	17	14	3½	–	3 1½	2 2¼	2 6½
		24	–	–	18	13	2	–	3 0½	2 2½	2 5¼
		18	–	–	19	13	[illegible]	–	2 10½	2 1½	2 4½
		12	–	–	19	12	[illegible]	–	2 9½	2 1½	2 3½
	Iron.	24 pr.	–	–	17½	14	2½	–	2 11½	2 6½	2 4½
		18	–	–	12½	15	2½	–	2 10	2 6½	2 3¼
		12	–	–	13½	16	2	–	2 9½	2 6½	2 4½

ARTILLERY TABLE I.—Composition of Field Batteries

Number and Species of Carriages of which Horse Artillery, or Field, Batteries of each nature are composed

	Field batteries				Colonial batteries				
							Mountain		
Nature of batteries	pr 18	pr 12	pr 9	Lt pr 6	pr 3	pr 3	pr 3	pr 3	pr 1
Nature of howitzers	in 8	pr 32	24	12	4⅖		4⅖	4⅖	
No of guns	3	5	5	5	3	4	3	3	4
Howitzers	1	1	1	1	1		1	1	
Ammunition Waggons, Guns	9	10	7	6	6 carts	4 carts	*	*	*
Ammunition Waggons, Howitzers	4	2	2	2	2 carts				
Spare carriage	1	1	1	1					
Waggon, Forge	1	1	1	1	†	‡	‡	‡	‡
Waggon, Store	2	2	1	1					
Waggon, Platform	1								
Store carts	1	1	1	1	§	‖	§	§	§
Total carriages	23	23	19	18	12	8	4	4	4
No of rounds per gun	180	148	166	223	154	165	165	108	232
" per howitzer	112	114	144	236	80		96	72	

The composition of the howitzer batteries seems not to have been yet decided on

Composition of Batteries *1st The batteries were composed of five guns and one howitzer,¶ with the exception* of 18 pounder batteries which are to consist of three guns and one 8 inch howitzer

2nd In case of reserve batteries formed of howitzers only, to consist of six pieces and their appropriate carriages

Rounds per piece 3rd. The number of rounds per piece required to sustain an action of some duration has been assumed as a criterion to regulate the ammunition waggon to accompany a battery of each nature, independent of reserves

Distribution of Ammunition 4th Adhering to the uniformity of packing and the power of substituting one limber or waggon for another the old proportion of case shot was considered too great, **Common Case** a diminution of it has taken place and that which is to be retained is to be of one sort, viz. 41 balls in tins for guns, which has permitted an increase in the number of rounds The case shot for howitzers to be not less than 4 oz balls

Spherical Case 5th. The spherical case is less efficient in the lower natures than the higher and is altogether useless in the 3 pounder, the average proportion of it to the total number of rounds per piece is nearly as follows

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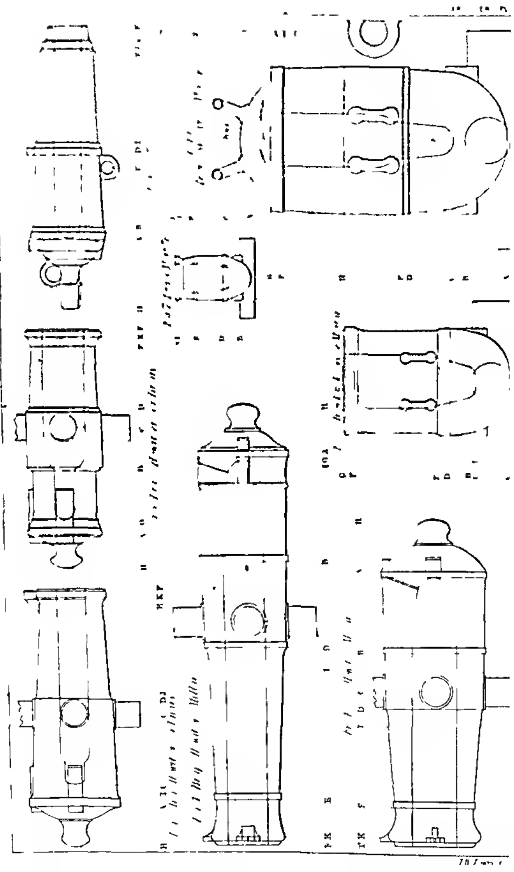
* Ammunition carried on mules' backs

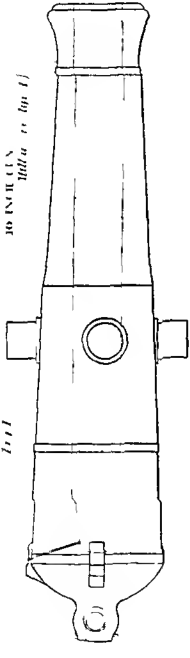
† There ought to be a small forge for this battery carried on two mules

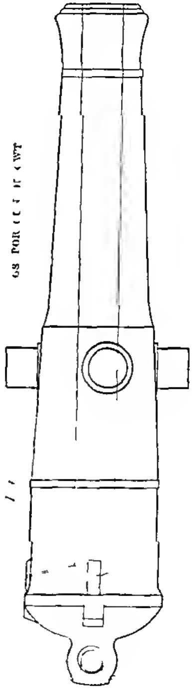
‡ A forge on back of two mules

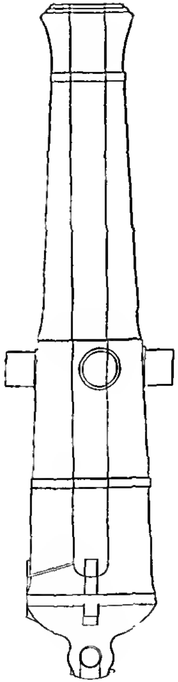
§ There ought to be a small cart drawn by two mules for a spare wheel mules shoes stores and tent &c ‖ Two mules for mules shoes stores and tent

¶ *Now (1852) of four guns and two howitzers*









8 inch, 32 pounder, 24 ,, , 12 ,,	howitzer	[illegible]
18 pounder gun		[illegible]
12 ,,		[illegible]
9 ,,		[illegible]
6 pounder, light		[illegible]

ical Spare unition — 6th The proportion of ammunition embarked for three months' consumption to be at least four times the quantity immediately accompanying each battery

ial Service — 7th A scale of equipments is added for smaller ordnance for local circumstances, such as light 3 pounder 4 feet, and Coehorn or 4⅖ howitzers on carriages of single draft, and carts for ammunition, and also for the 1 pounder ammuzette. These pieces are particularly adapted to the West Indies and other Colonial Services, where the limited movements they have to make must be regulated by the draft of mules or by the assistance of men

8th Scales have been formed for Mountain Service according to the two modes in most frequent use of the 3 pounder and Coehorn and 4⅖ howitzer of that construction, viz. the one by pack carriage altogether, and the other by draft, a shaft carried by a mule attached to the trail of the gun carriage

to Trail — 9th The latter mode (the shaft to trail) is infinitely to be preferred, as being easier for the mule, more readily brought in and out of action, as conveying more ammunition with the same power, and as being able to move on almost any road over which the former is capable of being transported

10th That of pack carriage is quite ineligible, and ought only to be resorted to when there is no other resource The gun weighs 252 lbs, and the howitzer 280 lbs This dead weight is concentrated on the top of the mule's back, and if by a false step or motion of the animal the weight inclines over the one side, the pack-saddle turns round and comes under the mule's belly, the piece cannot be put on the saddle without the greatest exertion of the men, and even then it requires that the animal should stand perfectly motionless

See 'Equipment,'—'Artillery,'—'Mountain,' and 'Carriage'

ARTILLERY TABLE J —Rockets

General Memoranda on the Elevations Ranges, and Lengths of Fuze at which the Shell may be expected to burst in the new pattern Rocket, in which the hollow head serves either as Shot or Shell

Lengths of Composition	24 pounder Elev	24 pounder Range yds	12 pounder Elev	12 pounder Range yds	6 pounder Elev	6 pounder Range yds	3 pounder Elev	3 pounder Range yds
If the whole length of the fuze be left in the shell	47°	3300	40°	3000	37°	2300	25°	1800
If the whole of the fuze composition is bored out, and the rocket composition left entire	27	2000	20	1500	15	1100	12	850
If the rocket composition be bored into within one inch* of the top of the cone	17	700	10	420	10	420	8	420

* In the 24 pounder 1½ inch

ATTACK.*—By Lieut.-Gen. Sir J. F. Burgoyne, G.C.B., R.E.

ATTACK OF FORTRESSES.

NUMBER OF TROOPS FOR A SIEGE.

The attempt to lay down a scale for the number of troops required for a Siege, in proportion to the size of the place or strength of its garrison, must be delusive. In one case double the number of the garrison may be sufficient, while in another six times its force may be inadequate.

The calculation will depend upon many contingencies; among the principal are,

1. Whether the besieging army will have any exterior force to guard against.

2. Whether the inhabitants of the adjoining districts are friendly or hostile, and if the latter, the extent of their energy, or power of annoyance.

3. Whether the garrison would be favourably circumstanced for making sorties, or the reverse.

4. The extent of labour and duties which would be required of the besieged, in proportion to the strength of the garrison.

5. The quantity of work and duties that would be required of the besieging force.

6. Facility or otherwise for procuring timber, brushwood, means of transport, and other accessories, in the neighbourhood.

7. Abundance or deficiency of Artillery and Ammunition, as well of Engineers' or Sappers' tools and stores, will influence in a great degree the number of troops of the Line necessary.

8. Consideration of the means of the besieged in the same particulars.

The Commanding Engineer, if well informed on the nature and circumstances of the place, as it is to be presumed he would be, would form his project of attack in detail, and calculate from the above and other considerations the force necessary for the operations.

Every species of service and duty must be brought into account, but the principal ingredient will be the number of men that must be daily actually in the trenches, employed in the guard of the works or working parties, as well for Artillery as for Engineers, giving them the proper number of reliefs.

If the Besieging Army was equal only to eight times the average number required constantly in the trenches, the service would be very hard; it would be equivalent to an assumption of each man having eight hours' working party duty, or twenty four hours' guard actually in the trenches every fourth day;† but in fact, from the number of men who never do that duty, such as cavalry, bands, orderlies, servants, men in charge of horses and sick, &c., the duty would be found to come at least once in three days, or probably nearer to every other day, upon the remainder, which would be far too severe.

The distance which many of the troops will have to march from their encampment to the trenches must also be considered.

The camp and fatigue duties, foraging and procuring and preparing materials for the siege, would afford heavy work for the proportion not in the trenches.

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* This article chiefly comprehends general principles; the details will be found under such heads as 'Battery'—'Sap'—'Mining,' &c.

† This calculation is on the assumption of half the number being on guard and half working party; as these proportions are altered, so will be the calculation; and also if the working parties are relieved every twelve hours instead of eight.

The Cavalry do no duty in the trenches, but will be proportioned to the service required for orderlies, escorts, maintaining communications, also for despatches, and pickets to oppose any sorties that may be expected to extend to any distance from the fortress. They are also employed in collecting materials for the siege, particularly any that are small in bulk, and can only be obtained at a distance, such as brushwood of best quality, and in particular that fit for gads or bindings for the fascines.

The Artillerymen must be proportioned to the force of the batteries, and should be in sufficient numbers to take upon themselves all that service that requires peculiar instruction and exercise, without occasion for other assistance from the Line than is wanted as ordinary manual labour, of which at times they will require a considerable amount.

OFFICERS OF ENGINEERS.

The smallest siege of a fort will require nine, that is, three brigades of two each and three Staff.

If the operation be somewhat larger, and to last ten or twelve days, there should be twenty Officers.

A regular hexagon attacked on the principle of Vauban would need forty Officers.

Sappers and Miners cannot be in too great numbers: if perfectly efficient and well trained, each Sapper in a siege will be worth three men of the Line up to a certain considerable number. They should, if possible, do every species of trench work, excepting what is of the most ordinary character; and by the facility and regularity with which they would perform it, a great deal of time would be saved, fewer men be required in the trenches, and much fewer casualties occur.

Each brigade of Officers should have the assistance of six men, to lay out the works and keep the working parties to a correct performance of their task.

Each head of a Sap, allowing for regular reliefs, will require twenty four.

For revetting batteries, six men per gun.

Of the parties making fascines and gabions, one fourth should be Sappers, particularly at first.

The following may partly be made up of artificers from the Line:

For preparing and afterwards laying platforms, four carpenters each.

For each gallery of a mine, requiring support by frame work, four carpenters.

These two last suppose the plank and wood to be ready prepared, at least in the rough.

For cutting out sleepers and planks in the woods, two pair of sawyers, per pit, should produce one platform from each pit in two summer days, including cutting down and trimming the trees, &c.

For a moderate siege of a fortnight or three weeks, where twenty Officers of Engineers and twenty five pieces of artillery are employed, the number of Sappers should not be less than 400.

A front of fortification attacked, according to Vauban, would require at least double that number, besides Miners in addition, where necessary.

Where they are not in sufficient numbers, a selection of artificers from the Line are attached to the corps for the siege, and receive such hasty instruction as can be given to them; but they are far inferior to Sappers.

As we know from experience that the Sappers can become as well disciplined and good soldiers as any other troops, they would act as perfectly efficient battalions, during periods of movements of the army in which their peculiar services as Sappers would not be required; while for attack or defence of posts, throwing up intrenchments, passage of rivers, forming or destroying bridges, &c., &c., their services would be invaluable.

There is a greater reason for a large proportion of Sappers as in an ordinary campaign the nature of their duties will probably lead to greater losses than are commonly sustained by soldiers of the Line

Although men from the Line instructed for the occasion will be but a very imperfect substitute for regular Sappers who have a thorough knowledge of their business they would be extremely useful to assist them in the artificers works and for performing various operations that require a greater degree of knowledge and intelligence than can be expected from the soldiers who may be found promiscuously in the working parties

From 200 to 600 (according to the class of siege) of such men selected paid and encouraged and attached for the siege to the Engineer Department would expedite the operations lead to a reduction in the numbers required for the ordinary working parties in a far greater proportion than their own force and enable the works to be more perfect

STORES

The Artillery and Stores for a siege train in general might perhaps be conveniently arranged in *proportions* commencing with a small one for attacks of forts or small posts

The details for the Artillery Service are for the consideration of that particular branch but 25 or 30 pieces of heavy ordnance including about 13 mortars and howitzers with about 1000 rounds of ammunition per gun and 500 per mortar and howitzer, might be considered as one proportion adapted *to very small sieges* to be multiplied according to the probable exigencies of the anticipated campaign — See 'Artillery Section v

The following may be esteemed a reasonable proportion of the principal Engineers' stores for the smallest siege *

List of Engineers' Stores forming one proportion for a small Siege — Some of the weights are estimated only

Actual weight by experiment cwt lbs		Estimated weight. cwt lbs
	2000 Pickaxes ($\frac{1}{10}$ pole or Miners picks)	182 0
	1800 Shovels	93 0
	200 Spades	10 0
13 0	200 Felling axes.	
3 80	50 Broad axes	
40 0	2200 Spare helves for different tools	
7 56	300 Bill hooks	
0 56	*5 Pit saws*	
1 0	10 Cross-cut saws.	
1 10	60 Hand saws	
1 8	30 Adzes	8 0
	30 Augers	
	30 Two-feet Rules	
	30 Planes	
	3000 Spike nails	
	2 Boxes of nails of sorts	
7 71	30 Crow bars.	
5 39	30 Sledge hammers or pin mauls	
	30 Gabion knives	
	60 Topping-axes	

* See Equipment, — Siege — Engineer

Actual weight by experiment cwt	lbs		Estimated weight cwt	lbs
		10 Sap forks		
		90 Earth rammers	9	0
		2 Chests of Carpenters' small tools		
		* 2 Do of Masons' and Miners' do do	4	0
		Miners' large tools for 3 Brigades	3	0
		Masons' do do for 6 Brigades	6	0
254	0	20,000 Bushel sand bags		
7	0	60 Fascine chokers		
		25 Gun platforms, 18 ft. × 12	650	0
		5 Mortar do 8 × 8	42	56
		1 Forge cart, with Smiths' tools	80	0
		Coals and steel for repairing tools	12	0
		2 Hand screw jacks		
		2 Large double blocks and tackles		
		2 Coils of 3 inch rope	7	0
		2 Ditto 1½ ditto		
		150 Platform screws, with nuts	3	0
		2 Steelyards, complete		
		10,000 yards of Hambro' line, for tracing works		
		10,000 yards of broad white tape, for night do		
		100 yards of saucisson or powder hose, made up	6	0
		100 yards of canvas for do or other purposes		
		Files, Setters, Dogs, Boxes, Chalk lines,		
		Grease, &c., for saws of all sorts		
		30 Masons' Levels		
		40 Plumb bobs, with lines		
		30 Dark lanthorns		
		300 lbs of Candles for do and Miners	18	0
		20 Grind stones		
		20 Rub or Whet stones		
		Twine, coarse, Packing needles, &c		
36	0	21 Marquees.		
		21 Bell tents		
		Plans, Papers, Books, Instruments, &c.	6	0
		180 Joints of scaling ladders, 10 feet long each	100	0
		4 Large tarpaulins	4	0

When the stores are to be conveyed by water, whether by sea, or river, or canal, and the means of transport are consequently plentiful, the stores may be greatly increased, and the service much expedited thereby. Platforms, timbers, and even fascines and gabions, can in such case, perhaps, be prepared previously, and at a distance, and conveyed to the siege.

Under any circumstances, a large proportion of every description of the small stores should be included, because they are easily carried, and may add much to the facility of the operations.†

* Chests of tools are no longer supplied: assortments are demanded as required.—*Editors.*

† The preceding list makes no allowance for casualties: there must be ample provision for such stores as bill hooks, shovels, sand bags, &c. &c., which are always liable to be purloined;—and every practicable arrangement should be adopted to prevent such losses.

All these estimates of men and means are given as the minimum of what are considered most appropriate and desirable, without being at the same time extravagant. Where exigencies of the Service require operations to be performed by small means, which is too often the case, of course the attempt must be submitted to, and the best made of those that may be available up to a certain point, when it may be the duty of the Commanding Engineer to declare them to be insufficient to afford any reasonable prospect of success.

INVESTMENT, ENCAMPMENTS, AND LINES OF CIRCUM- AND COUNTER-VALLATION, &c., UP TO THE OPENING OF THE TRENCHES.

The Investment is usually effected as much by surprise as possible, in order to shut the place up in as unprovided a state as may be.

It need not be complete (in occupying the entire circumference round the place), but it should be efficient; that is, the garrison should be shut up from receiving any succour, either in men or means, that can be of important service to it, or from a power of acting upon the flanks of the approaches.

At the siege of Badajos, in 1811, the right bank of the river was left open to the garrison for a few days, which was of no consequence as regarded any succour to be obtained from thence; but it gave a power which was taken advantage of, to run out guns day by day, which at a long range enfiladed the trenches.

The Encampments will very seldom be in the formal precise order found in the old books of Attack and Defence, of a circle round the place just out of gun-shot, but in the different positions which the country shall present as most favourable for the convenience of the troops and the service that each part may be called on to fulfil. An important point, likely to be forced, either from within or without, will naturally be taken up in the manner that shall present the strongest features for defeating such attempts.

In occasional situations, it may be desirable to draw the encampment somewhat close to the place, favourable undulations of ground may enable this to be done with security and to great advantage. In others the troops may be at a greater distance, in positions favourable for other objects.

The same reasoning applies to Lines of Circum- and Counter-vallation, the effect of which would generally rather be obtained by adapting the position of the troops and defences to the features of the country under the ordinary principles of military positions and intrenchments, than to a regular circular line round the place, the applicability of which under the present mode of warfare can scarcely be conceived.*

Other considerations having been provided for as above, it will be desirable to bring the encampments of the several parts of the besieging force as conveniently near for reaching the trenches as possible, and as large a body of troops as can be allotted to one part should be encamped on the side to be attacked, in order to give peculiar security to the parks of artillery and several depôts, and also to be more at hand for the duties of the siege.

The principal Engineers' Dépôt should be out of easy range from the garrison, and not only out of sight of it, but the access to it for stores and materials from different directions should be, as much as possible, unseen.

The parks of artillery must be peculiarly secured from risk of exposure to the fire from the garrison.

The fatigue of marching between the remote parts of the encampments and the trenches is so great an addition to the duties of the siege, that it will be an im-

* See Blockade.

portant study, and worthy of some labour, to render the communications between them, in addition to being good and complete in bridges, &c., &c., *as short* as possible, consistently with security.

At the blockade of Malta, in 1800, advantage was taken of the ordinary loose stone wall fences of the country; and by connecting and raising those that were convenient and parallel to the works, by closing gaps, and opening cross-walls, to *effect a communication all round the fortress, in many parts not more than 200 or 300 yards from the place*; and though only a screen, still being hidden from view, it was perfectly secure, and of great service. It was more costly and inconvenient to the garrison to destroy this screen than to the blockading force to maintain it.

In Fortresses besieged, a screen of mere canvas across narrow openings that were exposed to musketry has frequently enabled the communication to be maintained free and secure.

Hollow roads, covered ground, buildings, walls and hedges, &c., might, under many circumstances, be connected artificially into communications covered from view, that would be of great service in this way.

From the period of the first investment to the opening of the trenches, every necessary reconnoissance of the place is made by close investigation of the Officers of Engineers, who are to be protected while executing this service by covering parties of the troops.

The Plan of Attack being definitively arranged, the situations of the additional troops that may be brought to the immediate neighbourhood of the attack, as well as of the several dépôts, should be defined, and as many points fixed and marked for the approaches and works of the siege in detail as possible,—always under the greatest precautions against the garrison obtaining a knowledge of the proposed operations.

From the first period of the investment also, parties should be sent out to collect platform timbers, fascines, gabions, &c., &c., which should be brought in so far as can insure subsequently the least possible extra carriage to the final dépôts in rear of the attacks.

This will probably require the continued service of all the means of transport that brought up the stores in the first instance, and as the horses or cattle so employed must be subsisted in the district itself, in addition to Cavalry, Artillery, &c., it will tend, among others, to shew how many more difficulties are opposed to carrying on a siege in winter, than merely the effect of climate on men and animals.

OBJECT AND PRINCIPLES OF ATTACKS.

To ascertain what works will be necessary for any siege, it may be well to revert to first principles.

The object to be attained in the Attack of a Fortress is to make a breach or passage in its walls, capable of allowing it to be stormed with superior forces.

If the place has only a single line round it, and that exposed to view to the foot, or very near it, a single battery, established at from 200* to 400 yards distance, may be sufficient to effect the breach, and the troops can then storm the place at once.

Unless there should be natural cover up to the site of the battery, a covered approach must be made to it for the troops and the guns taken by the most convenient roads or directions, independent of the approaches, during the night.†

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* Practicable breaches may be made from greater distances, by increasing the power of Artillery, and by an extension of time.

† It happens occasionally that daylight comes on while this is in operation, in which case any gun that may necessarily be left in an exposed situation is covered from view as well as may be, by branches of trees, &c., &c., till the next night, and thus sometimes escapes observation.

In proportion to the fire of artillery that the garrison can bring to bear upon the single battery will be the difficulty of effecting the breach, or the breach may have a flanking fire to bear upon it (and a very small flank will have a powerful effect on the assailants); in either event these means of resistance, if too powerful, must be previously silenced or greatly reduced, which must be effected by other batteries, and probably by some works carried nearer

When the garrison is in sufficient number, and has facilities for making sorties, the batteries must have covered communications to connect them, and cover for troops to support them; and in proportion to the force and facilities possessed by the garrison must these precautions be increased.

If the wall of the fortress be not exposed to fire from a distance, the breaching battery must be established nearer; and when it has a revetted counterscarp, the approaches must be carried close to it, to enable a clear passage to be formed to the breach

Certain outworks under different circumstances will demand similar works of Attack; and during the whole proceeding there must be covered approaches and assembling places, for the passage of the troops, and for the lodgement of sufficient number to protect the batteries from sorties.

From these data will be perceived the necessity for giving such a direction to the approaches, which are formed in zigzags, and to the parallels, as will secure them from enfilade, and these works will be more or less in proportion to these considerations, to the size of the fortress, and strength of its garrison (See 'Plans of Attack')

It is usual to lay down a system of Attack in three parallels the first at about 600 yards distance, the second at 300, and the third on the glacis, but it should be borne in mind that this is only to give an idea of the mode of carrying out the general principle under ordinary circumstances, and not as a fixed rule, for the siege of a place garrisoned or supported by several thousands of men, in fact by a small army, with its environs exposed to its fire for a considerable distance, may require parallels and support from 800 to 1200 yards off, and to be much more numerous and irregular than the three defined parallels above described, as it would be impossible in that case to establish yourself at once so near as within 600 yards, while in proportion as the force of the place is reduced, the operations may be diminished down to the minimum of the single breaching battery

It may be mentioned here, that a large place strongly garrisoned, however inferior the fortifications, is far more difficult to take than a small one, however complete and perfect its works.

There are many reasons why this should be the case

1 It is difficult to conceive a case where such a place could be completely invested, on account of the great extent of encampment out of gun shot round it, every part would be weak, and liable to be attacked by the concentrated force of such a garrison

2 The space at the disposition of the garrison would be so large, that every part of it off immediate duty on the front of Attack would be quiet and undisturbed

3. The different fronts would approach nearer to straight lines, and their works probably cannot be enfiladed; or if an angular or salient point be selected for Attack to give that advantage that very salient would probably afford convenient position for strong and multiplied interior retren[illegible]

4 Every sortie becomes a battle of armies [illegible] lead to a great disaster

5 Abundant supplies of artillery and m[illegible] required, from the many fronts not attacke[illegible]

6 Retrenchments may be formed in succe[illegible]

will be very efficient when on a small front, backed by strong forces, and perfectly secured in flank, where the assailants advance from confined trenches, subjected to heavy vertical and other fire

On the known advantages which even a few slight works, on a tolerably good position in the field, will give to an army of very inferior force, it may be conceived how strong must be one protected by any thing of the character of permanent fortification

Subject to the above mentioned caution, we give plans of the regular system of Attack, as laid down by Vauban and never altered since, as the best *illustration* of the nature of the principal operations

On referring to recorded accounts of Sieges, it will be found, that against powerful garrisons the besiegers have usually under estimated the required works, and have experienced the necessity, as they proceeded, of obtaining more support, and at greater distances than at first intended: this error has very probably arisen from the impression left in the minds of the Engineers by the precise form and proportions given in Vauban's Diagram An unnecessary amount of extra work has, from the same cause, (of adhering to fixed rules, instead of attending to principles) been frequently applied in the siege of small places, but the evil in that case is not so apparent

PRINCIPLES THAT MAY SERVE TO GUIDE THE DETERMINING OF THE FRONT FOR ATTACK.

As regards *natural causes* the fronts of a Fortress are usually deemed *unattackable* by siege operations when situated on a steep rock exceeding 40 or 50 feet in height Also those surrounded by water that cannot be drained off, or by marshes, or whose front, on which the approaches must be carried is seen in flank and reverse by ground occupied by the garrison in accessible situations, having works on it which cannot be silenced, or generally in a re-entering angle

The Attacks of Fronts are *very difficult* when the approaches must be carried over rock or very stony ground, or among roots of trees, or in a very wet soil, particularly where the natural inclinations will not admit of a free drainage of the trenches * Also when descending towards works that are on commanding elevations, or approaching them on a lower level, not being in the same plane, or when the approaches must be carried across a narrow confined space presenting a smaller front than that of the place

As regards the nature of the works the difficulties to the progress of the besiegers may be greatly impeded when the works are countermined,—where the ground to be passed over may be inundated;—where the front is in one very extended straight line, or nearly so,—where the ditches are cut out of solid rock,—where the flanks have casemated guns,—the revetments en décharge —with ditches that by means of sluices can be inundated and dried at pleasure,—or where there is a succession of lines of works, each requiring close breaching batteries —or where the ground and buildings immediately within the front are very favourable for being made into strong retrenchments, for, generally speaking, the nearer the works of defence, whether permanent or temporary, are to the Body of the Place, the greater obstacles will they prove to the besiegers

Circumstances favourable to the Attack are of course the reverse of the above, also where the ground to be passed over presents much or occasional cover, either from its inclinations or from artificial objects, as buildings, mounds, trees, enclosures, &c

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* Drainage of all parts of the trenches is very necessary even in dry soils to prevent the effects of rain alone

with the army, 100 mules were allotted, by the Duke of Wellington's orders, for the conveyance of a small dépôt of intrenching tools and Engineers' stores. In 1813, a pontoon train was organized and added, and some companies of Sappers joined from England, but unfortunately not long before the Peace of 1814.

In 1815, with the army in France, companies of Sappers, and dépôts of intrenching tools, &c., on a much larger scale, were attached to each division of the army.

Notwithstanding this commanding testimony to the value of preparation for military labour in the field, and the importance attached to it by that paramount authority, there is every reason to believe that the same apathy as heretofore manifested with regard to the exertions to be used in such operations would still be found to continue in the Army, and it therefore cannot be too strongly deprecated. Whatever may be the sentiments or efforts as regards ordinary work, it is impossible to stir a step without it in a siege, or to evade the necessity for exertion then; still we can state from experience that in the Peninsula, the latest service we have of the kind in Europe, the amount of work executed in the trenches by given numbers of men in given times was very far less than what it might have been; and even that was performed in a listless manner: the working parties were handed over to the Engineers, their own Officers rarely interfering to promote the operation, unless in cases of a Sortie or Assault, when they would immediately resume their habitual energy.

It is the duty of the Engineer to arrange the men and tools, and to give every necessary direction and attention for the labour being properly applied; but the Regimental Officers should be entirely responsible for the quantity of work performed; and it should be held equally discreditable to a corps to be deficient in exertion in that branch, as in the neglect of any other duties.

*The result of experience shews that the spirit and efficiency with which any corps conducts itself in working parties is no mean criterion of its general order and discipline.**

The consequence of want of exertion in working in the trenches is very serious, independently of the loss of time in the operation, when the difference of a day or two may lead to success or the reverse, and affect the whole campaign: a larger number of men are employed and exposed, and this severe duty comes oftener on the men, for it is manifest that if 500 men could by proper exertion do what you are obliged to bring 600 men for, 100 men are employed in the trenches throughout the siege more than necessary, and this is not an exaggerated proportion to allow for what has been the nature of performance in such duties.

It was a common practice, and one very injurious to this service, as shewing the injudicious view taken of it, namely, that of keeping the roster for it by detachment, according to the precise strength of the regiments, and not by corps, as it should have been: the consequence was, that working parties of a few hundred men were composed of officers, non commissioned officers, and men of various different regiments. It may be conceived how little order or discipline could be kept up in such cases, particularly by night, and how little these bodies imagined it to be necessary: as a natural result, many of the men made no scruple of evading the work,

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* In a *Siege*, more than in any *other service*, there are opportunities *for individual acts of intelligence, spirit*, and *exertion*, and such acts may be of very great advantage; whereas in the *Field* they are only instances of a display of courage.

Hence it would be peculiarly desirable and politic at sieges to establish a system of rewards for

which was done with impunity, and the rest worked very indolently This practice should be abandoned, and all working parties furnished by corps, each with their own Officers, even although it may make a little inequality in the proportions according to their precise strength

The most advantageous mode of applying soldiers to Field or Siege work will be, where it is possible, by tasks, which will be described hereafter

With reference to the labour of soldiers in the field in general,—there is one consideration that must not be forgotten in estimating the amount of work that may reasonably be demanded from them in given times, which is, that during the hardships, deprivations, and fatigues of a campaign, they have not by any means the physical powers of an ordinary labourer living at his own home Their task should be calculated accordingly, but whatever it may be, it should be executed with alacrity and spirit *

ARRANGEMENTS PECULIAR TO THE ENGINEER DEPARTMENT

The whole of the Engineer department will encamp at or near the Dépôt.

The Ordnance Assistant Commissary will have charge of the office and all stores, and will be responsible for their care and maintenance

He will have to assist him, the Clerks and Conductors of Stores, and a small detachment of Sappers

The tools and stores of all sorts will be kept in order and readiness to be delivered out at a moment's warning, during night or day, by the Sappers of his detachment on duty

He will send a Sapper daily to the trenches, to collect all the broken and spare and dispersed tools, with the assistance of a few men from the working parties, which the Officer on duty will give him

The broken tools will be immediately repaired by the Smiths and Carpenters employed for that purpose

The fascines and gabions must be regularly piled, and not allowed to be removed except for the works

The sand bags will require particular attention, to prevent their being purloined for many purposes to which they can be applied, as will also the axes, hatchets, and bill hooks

If they should not have the advantage of any other protection, the stores and tools will be enclosed by a rope fixed to picketing posts, and no one allowed within it by the sentinel but parties having business there

The Artificers, Fascine Makers, &c, must be responsible for the tools delivered to them, of which a record is to be made

The Ordnance Commissary has charge of the workmen in the Dépôt

His Clerks will enter regularly an account of receipt, issue, and expenditure of stores, of all persons attached to and employed by the Engineer department, and of their pay, either for day or task work.

The workmen should be paid every evening

The Carpenters are divided into numbered brigades of four in each.

The Sappers into brigades of eight.

The Miners into brigades of four

As soon as parallels are entirely established, and safe from being carried by sorties,

* It is very desirable to provide some regular organized means by which the different parties could always obtain water without having to send numerous detachments out of the trenches altogether with imperfect means for bringing it in small quantities.

small depôts are formed in them, where the Officers of Engineers will be able to send readily for any article required. A guard is placed over them, with at least one Sapper; and the platforms (among other things) may be collected there by degrees, brought in by the working parties, to be in readiness as soon as required, and from whence they will be less liable to be mixed than when brought at once from the main dépôt to the batteries.

The following will be the dimensions and prices* paid for the fascines and gabions, &c. brought in by the different parties.

The prices are calculated on the supposition that the parties find their own materials where they are in plenty and near at hand.*

			ft	in
Large Sap Gabion ready for stuffing, 6s. each	Diameter (from centre to centre) of pickets		3	6
	Height of the watling		5	0
	Distance asunder of the seventeen pickets		0	8
Common Gabion, 1s. each	Diameter		2	0
	Height of the watling		2	6
	Eight pickets or stakes	Length of each	3	0
		Diameter from 1 to	0	1½
Battery Fascines, 18 feet 2s. 6d. 12 feet 1s. 10d. 9 feet 1s. 5d.	Length		18	0
			12	0
			9	0
	Diameter 10 inches, or circumference		2	7
	Distance of the gads asunder		0	9
Fascines for stuffing the large Sap Gabion, having a Stake or Picket within, each 1s.	Length		5	0
	Circumference		2	0
Tracing Fascines (Fatigue work.)	Length		5	0
	Circumference		2	0
Fascine Pickets (Fatigue.)	Length not less than		3	0
	Circumference at thick end from 3 to		0	5
Gads (Fatigue.)	Length not less than		4	6
	Circumference at thick end from 3 to		0	5
Stakes for the Horses or Trestles for making Fascines on	Length		5	0
	Circumference about		0	10
Horses or Trestles all ready, the 6 for an 18 feet Fascine 8s.	Distance asunder		2	6
Fascine Mallets (of hard wood.) 1s. 6d.	Length of the head	8 or	0	9
	Diameter of ditto	5 or	0	6
	Length of the handle	from 3 to	5	0
Each Gun Platform† 10s.	3 Sleepers.	Length of each	14	0
		Width	0	5
		Thickness	0	6
	1 Hurter	Length	8	0
		Width	0	8
		Thickness	0	8
	14 Planks	Length of each	10	0
		Width	1	0
		Thickness	0	2

* These prices will of course be liable to variation from localities: those given above are taken from memoranda of Peninsular Service.

† These platforms are of the highest advisable description, and will weigh less than those given in the 1st p. 3. Whatever changes may occur in the construction of platforms, &c. &c. the above as the result of much experience have been retained as valuable precedents, though they should be but partially applied. *Editors.*

			ft	in.
Each 13 or heavy 10 inch Mortar Platform, 8s.	3 Sleepers	Length	7	0
		Width	0	8
		Thickness	0	8
	11 Sleepers.*	Length	6	0
		Width	0	8
		Thickness	0	8
Each 8 inch Stone or other light Mortar Platforms, 7s	12 Sleepers	Length	8	0
		Width	0	6
		Thickness	0	6
Splinter-proof Timbers, for Magazines, 1s 6d each		Length	from 9 to 12	0
		Width	from 4 to 0	10
		Thickness	from 6 to 0	10

Carpenters, for pointing, trimming, and cutting pickets to their proper length, may be allowed 1s per 100, the pickets being brought in for them

The Sappers and Men of the Line attached to the department are paid according to the Regulations

The Fatigue parties from the Line, for collecting materials in the rough and in bulk, and the ordinary working parties during the siege, are not paid

The Serjeant of the Dépôt will receive these stores, and give an account regularly of the quantity delivered to the Clerk, to be entered in the books, as well as all issues.

All the articles which are not well made and nearly according to the prescribed dimensions will be rejected; for those accepted, a receipt will be given as they are brought in

Gabions,† to be received, must be strong, stand firm, and upright, and the work close;—a few rows of wattling, well bound together by at least four gads at top and bottom, and in no part of their length or diameter varying more than 2 inches from the proper dimensions

Battery Fascines,† to be accepted, must be straight and cylindrical, closely bound with good thick gads not more than 9 inches asunder, and the knots well tied and in a line, the length to be exact, and the thickness in no part to vary more than one inch from that prescribed.

DIRECTIONS TO THE OFFICERS AND ENGINEERS, AND THEIR DISTRIBUTION.

The Second in Command will be Director of the Attacks He will be obeyed by the Department in all parts, and must pay his particular attention to preserve regularity in the trenches, and more especially to the laying out of all new works

The Brigade-Major and Adjutant will keep in order the Returns, Rosters, Official Letters, &c., and have particular charge of the Sappers they will occasionally be able to visit the trenches to assist the Commanding Officer, or for his information

A certain number of Officers will be divided into numbered brigades of two in each

The unattached Officers may be in the first instance employed in setting to work the Gabion and Fascine Makers, and in arranging the Platforms, or they may be put as supernumeraries to the Brigades

A nominal list will be made out of the distribution of the Officers and Sappers.

The hours of relief will be 4 P M,—Midnight,—and 8 A M Or, 5 P M,—3 A M,—and 9 A M, as found best, to which the Officers must make it a point to be punctual, particularly for the afternoon relief There should be some means taken

* Used as planking, they were unnecessarily thick

† See 'Gabion,'—'Fascine'

of fixing the time by signal or otherwise, once in each twenty four hours for the whole encampment.

The Officers of Engineers must pay particular attention to the different directions for carrying on the works, which will be given out by the *Commanding Engineer*. They will recollect that the main object in a Siege, where the new work is generally commenced at night, is *arrangement*; upon that point too great a stress cannot be laid; they must therefore use their utmost exertions to preserve regularity and system in all the operations. It is better to delay half an hour, or even an hour, in commencing work, than to begin in confusion; they must call upon the Officers of the working parties *to enforce their directions, and to encourage the greatest* exertions on the part of the workmen.

The Commanding Engineer's daily order, given at 2 P.M., will make every one acquainted with the works to be executed during the ensuing twenty four hours. The Officers must cause their Sappers to see every article they will require prepared in time; that is, tools or stores laid out, and tracing lines, measuring rods, &c., prepared, and the Senior Officer of each Brigade will order the arrangement of his party.

They will report particularly in writing to the *Commanding Engineer the good* conduct of any of the Sappers and Miners, as well as any instance, if such should occur, of misconduct of any kind, or of want of spirit, exertion, or ability.

The Senior Officer of each Brigade will, on his return from duty, send in to the Office a written account of the extent of work performed, with remarks on the conduct of the working parties and of the corps they were furnished by, as well as a detail of the occurrences of his relief; such as, of Sorties, of the nature of the fire from the enemy, and of our own, with their apparent effects, the works the enemy may be carrying on, as far as he can perceive, &c. These Reports revised by the Director, will be copied into a book or Journal, kept at the Royal Engineers' Office for that purpose by the Adjutant.

They will give certificates in writing to the parties for all task work, for which purpose they will find it convenient to go prepared with everything written on small slips of paper but the quantity of work, which can be filled in on the spot. For the Sap, and such works, the payment will be made on these certificates.

OPENING THE TRENCHES AND FIRST PARALLEL.

It is usual to undertake, on the first night of opening the Trenches, the entire of the First Parallel, or protective position, and its approaches. See figs. 2, 3, and 4, Plate I.

We will assume in this case that this Parallel is to be at about 600 yards from the salient angles of the covert way, with two or three approaches, as shewn in Plate I.

The 600 yards distance for the First Parallel is from the main works of the place, without regard to any detached works, unless they are large; it is considered in ordinary cases the best, because beyond the effect of much injury from grape shot or *musketry, or of any serious sorties from* a garrison of moderate strength, and because it is about the extreme distance for very steady howitzer practice.

The Parallel is extended in length 50 or 60 yards beyond the prolongation of the extreme faces of the works *of the front to be attacked*, and *turned round at the ends* as a protection to each flank, or should be finished by a redoubt *or palisading*, where there is much to apprehend from sorties, if the garrison is strong. See Plate I.

The approaches in zigzags should be directed to a point at least 30 yards outside of the extreme parapet or covered way of the garrison from whence fire could be directed on them, in order to avoid effectively not only enfilade but ricochet shot.

In section the parallels are 10 feet wide, including the front banquette, and the

approaches 8 feet without a banquette; each of them having an average depth of 3 feet, with a slight fall from front to rear for drainage, and which also affords some advantage in defilading the trench, or improving its cover.* Plate I figs. 2, 3, 4.

Means for getting easily out of parallel and approach to oppose sorties, particularly from the former, should be afforded.

The interior slope and top of the parapet of the parallel is shaped with the shovel, so as to give the most cover with a proper height (4 feet 2 inches) to fire over

In great Sieges, or Attack of Fortresses of the 1st and 2nd orders, the width of the parallel will require to be increased, and in very small ones may be reduced

The approaches forming the roadways into the trenches could hardly be reduced under any circumstances, and those of the first entrance, that is, up to the first parallel, will probably be better of greater width, to give more freedom of passage

It will be an object to endeavour to conceal from the garrison the *time* of the opening of the trenches, because if the first night's work can be executed without interruption, the operation will be much facilitated, and many casualties saved

This is to be done by keeping the assembling of the troops for the purpose, and other demonstrations, as little perceptible as possible

The Covering† and Working parties will be given from the nearest encampment, the latter will assemble in due time at the Engineers' Dépôt, where the tools and materials will have been laid out in readiness for them

To preserve ordinary appearances, the Pickets usually employed to confine the garrison to their works will proceed in their accustomed manner and time: they will form part of the covering party for the night

Immediately after the darkness of the night is sufficiently complete to *insure* the impossibility of observation from the enemy, the Engineers, aided by their Sappers, proceed to mark out, as rapidly as they can, the lines of parallel and approaches

No saving of time, however, is to justify any degree of inaccuracy, they will therefore have considered deeply, and by as many actual trials as possible, in recognizing and fixing the localities, how to secure the opening of the trenches with accuracy and rapidity.

As soon as the necessary given points shall be found, the especial Covering party for the protection of the work will be led out to their positions by Officers of Engineers

The main bodies will be posted in line about 100 yards in rear of the parallel that is to be formed, and in the intervals and on the flanks of the approaches

If any part of it can be placed under cover of rising ground, buildings, &c., advantage will be taken of the circumstance

Strong advanced Guards are detached to about 100 yards in front of the parallel; they will remain collected in small parties, posting in their front again, a line of Pickets near enough to prevent any one passing between them unobserved.

To prevent mistakes and false alarms, the working parties must be made acquainted with the fact of a portion of the covering parties being in their front

In laying out the lines, the principal points are first marked with pickets made visible by bunches of straw, or white paper, about their heads, and the intervals

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* The rear of the trench is much the most exposed to the fire from the garrison; although not actually in view many casualties happen there from shot dropping in immediately over or through the top of the loose earth parapet

† The protective force has usually been denominated in the British Service "*the covering party*," which may be correct previously to the construction of any of the trenches; but subsequently "*guard of the trenches*" would seem to be more appropriate and is more in accordance with the practice of other nations

of fixing the time by signal or otherwise, once in each twenty four hours, for the whole encampment.

The Officers of Engineers must pay particular attention to the different directions for carrying on the works, which will be given out by the Commanding Engineer They will recollect that the main object in a Siege, where the new work is generally commenced at night, is *arrangement*, upon that point too great a stress cannot be laid, they must therefore use their utmost exertions to preserve regularity and system in all the operations. It is better to delay half an hour, or even an hour, in commencing work, than to begin in confusion, they must call upon the Officers of the working parties to enforce their directions, and to encourage the greatest exertions on the part of the workmen

The Commanding Engineer's daily order, given at 2 P M, will make every one acquainted with the works to be executed during the ensuing twenty four hours The Officers must cause their Sappers to see every article they will require prepared in time, that is tools or stores laid out, and tracing lines, measuring rods, &c., prepared, and the Senior Officer of each Brigade will order the arrangement of his party

They will report particularly in writing to the Commanding Engineer the good conduct of any of the Sappers and Miners, as well as any instance, if such should occur, of misconduct of any kind, or of want of spirit, exertion, or ability

The Senior Officer of each Brigade will, on his return from duty, send in to the Office a written account of the extent of work performed, with remarks on the conduct of the working parties and of the corps they were furnished by, as well as a detail of the occurrences of his relief, such as, of Sorties, of the nature of the fire from the enemy and of our own, with their apparent effects, the works the enemy may be carrying on, as far as he can perceive, &c These Reports, revised by the Director, will be copied into a book or journal, kept at the Royal Engineers' Office for that purpose by the Adjutant

They will give certificates in writing to the parties for all task-work, for which purpose they will find it convenient to go prepared with everything written on small slips of paper but the quantity of work, which can be filled in on the spot For the Sap, and such works, the payment will be made on these certificates.

OPENING THE TRENCHES AND FIRST PARALLEL

It is usual to undertake, on the first night of opening the Trenches, the entire of the First Parallel, or protective position, and its approaches See figs. 2, 3, and 4, Plate I

We will assume in this case that this Parallel is to be at about 600 yards from the salient angles of the covert way, *with two or three approaches, as shewn in Plate I.*

The 600 yards distance for the First Parallel is from the main works of the place, without regard to any detached works, unless they are large, it is considered in ordinary cases the best, because beyond the effect of much injury from grape shot or musketry, or of any serious sorties from a garrison of moderate strength, and because it is about the extreme distance for very steady howitzer practice

The Parallel is extended in length 50 or 60 yards beyond the prolongation of the extreme faces of the works of the front to be attacked, and turned round at the ends as a protection to each flank, or should be finished by a redoubt or palisading, where there is much to apprehend from sorties, if the garrison is strong See Plate I

The approaches in zigzags should be directed to a point at least 30 yards outside of the extreme parapet or covered way of the garrison from whence fire could be directed on them, in order to avoid effectively not only enfilade but ricochet shot

In section the parallels are 10 feet wide, including the front banquette, and the

approaches 8 feet without a banquette; each of them having an average depth of 3 feet, with a slight fall from front to rear for drainage, and which also affords some advantage in defilading the trench, or improving its cover.* Plate 1 figs 2, 3, 4.

Means for getting easily out of parallel and approach to oppose sorties, particularly from the former, should be afforded.

The interior slope and top of the parapet of the parallel is shaped with the shovel, so as to give the most cover with a proper height (4 feet 2 inches) to fire over

In great Sieges, or Attack of Fortresses of the 1st and 2nd orders, the width of the parallel will require to be increased, and in very small ones may be reduced.

The approaches forming the roadways into the trenches could hardly be reduced under any circumstances, and those of the first entrance, that is, up to the first parallel, will probably be better of greater width, to give more freedom of passage.

It will be an object to endeavour to conceal from the garrison the *time* of the opening of the trenches, because if the first night's work can be executed without interruption, the operation will be much facilitated, and many casualties saved

This is to be done by keeping the assembling of the troops for the purpose, and other demonstrations, as little perceptible as possible

The Covering† and Working parties will be given from the nearest encampment, the latter will assemble in due time at the Engineers' Dépôt, where the tools and materials will have been laid out in readiness for them

To preserve ordinary appearances, the Pickets usually employed to confine the garrison to their works will proceed in their accustomed manner and time they will form part of the covering party for the night

Immediately after the darkness of the night is sufficiently complete to *insure* the impossibility of observation from the enemy, the Engineers, aided by their Sappers, proceed to mark out, as rapidly as they can, the lines of parallel and approaches.

No saving of time, however, is to justify any degree of inaccuracy, they will therefore have considered deeply, and by as many actual trials as possible, in recognizing and fixing the localities, how to secure the opening of the trenches with accuracy and rapidity

As soon as the necessary given points shall be found, the especial Covering party for the protection of the work will be led out to their positions by Officers of Engineers

The main bodies will be posted in line about 100 yards in rear of the parallel that is to be formed, and in the intervals and on the flanks of the approaches

If any part of it can be placed under cover of rising ground, buildings, &c, advantage will be taken of the circumstance

Strong advanced Guards are detached to about 100 yards in front of the parallel; they will remain collected in small parties, posting in their front again, a line of Pickets near enough to prevent any one passing between them unobserved

To prevent mistakes and false alarms, the working parties must be made acquainted with the fact of a portion of the covering parties being in their front

In laying out the lines, the principal points are first marked with pickets made visible by bunches of straw, or white paper, about their heads, and the intervals

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* The rear of the trench is much the most exposed to the fire from the garrison, although not actually in view many casualties happen there from shot dropping in immediately over or through the top of the loose earth parapet

† The protective force has usually been denominated in the British Service "*the covering party*," which may be correct previously to the construction of any of the trenches, but subsequently "*guard of the trenches*" would seem to be more appropriate, and is more in accordance with the practice of other nations

defined by straight lines of white tape,* which is to denote the actual line of the excavation

Each man of the working party carries a pickaxe and shovel, and a tracing fascine (if the latter be employed); the fascine on the shoulder that will be towards the enemy as he files into his position to work

When the lines for the works are sufficiently marked out, the Brigades of Engineers, with their Sappers, lead out the working parties direct to the several points from whence each is to be arranged.

When the head of the file reaches the fixed point *from* whence that party is to commence, he is halted, and his fascine taken by a Sapper and laid parallel to the white line, and at 18 inches from it; the next man files up, and the same is done with regard to his fascine, and so on till the whole are placed, every man in succession sitting down on his fascine, which thus marks the length of trench allotted to each.

There must be no wavering, or chance incurred of misleading the covering or working parties to their precise points in the nearest direction, and by that which is most clear of obstructions; if at all necessary, men with dark lanthorns will be fixed at particular points, essential for obtaining the proper direction

Lanthorns for this purpose may be fixed or hung on a disc of tin or wood, to form a screen on the side of the garrison, and must only be intrusted to a N. C. Officer of *Sappers, or some man who can be thoroughly depended upon for steadiness and* intelligence, to prevent its being observed by the enemy. The light should be small, and not allowed to strike on any *near* object

When the *whole* are placed by *all* the Brigades, and not till then, the word is passed, or some signal given, (that cannot be perceived by the garrison) to commence work, which is then to be pushed on vigorously; but, if still undiscovered by the enemy, with as little noise as possible.

Should no tracing fascines be employed, the proceeding is carried on in the same form; but other means must be adopted for placing the men at a proper distance asunder.

The first night's work is necessarily a short one: suppose the excavation actually to commence at nine or ten o'clock of a summer's night,† there will be probably five or six hours available in the dark, and about three more after dawn

It is usual to anticipate but a small portion of work to be executed on this first night, each workman having 5 feet of length of trench, and the given depth of 3 feet to excavate, only 4 feet in width is the quantity laid down as reasonable to expect, being less than 2½ cubic yards. This should be considered as the very minimum, even in unfavourable soils, (not being rock or swamp,) or when the weather is particularly bad, or the party under serious interruption from the enemy; it is a very trifling amount of work for a man to execute, and half of it will be done by him voluntarily within the first hour, in order to gain cover,—so small a result leads to the space obtained being most confined, and inconvenient to contain the guard as well as the workmen in the morning, besides that many other advantages would arise from greater energy in the first night's work

Indeed, it is on record that the excavation for parallel and approach is frequently completed during the first night, leaving only the shaping and putting banquettes for the next party.

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* In Foreign Services a light-coloured rope is usually employed, white tape, or long strips of linen however of from 1 to 2 inches broad as used in our Service, is particularly conspicuous in the dark, very portable easily procured and managed, may be occasionally saved, washed and used again and is considered altogether preferable

† Latitude 38°

In reference to Siege and Field works, the quality of the soil is sometimes divided into three classes

1 Light, and to be worked with the spade and shovel alone

2 Requiring one pickaxe to two shovels

3 Requiring one pickaxe to each shovel, which may be deemed the hardest, not including rock or large boulder stones

The third case, consequently, would require double the number of men to execute any given quantity of trench-work that the first would, or at given distances asunder the men would do half the amount of excavation.

A man working by day for ten hours could excavate in the light soil, and throw out earth with the shovel in such a trench, to the amount of about 10 or 12 cubic yards

A *complete parallel* 10 feet wide by 3 deep, at the length of 5 feet per man, would be less than half that quantity, that is, little exceeding 5½ cubic yards, and should be done with tolerable ease in light soil during the first night, or, in more difficult soils requiring occasional use of the pickaxe, 8 feet in width (under 4½ cubic yards) might be completed

Either of these quantities, therefore, according to circumstances, might be expected for the first night's work, except in peculiar cases of difficulty

During the night, and particularly just before perfect daylight, the men must clear away the *upper step of the banquette or berm of 18 inches in front of the excavated* line, and lower the top of the parapet, throwing the stuff in both cases well to the front, in order to leave space for the earth subsequently to be excavated, without the necessity in the day of exposing the workmen to the enemy's fire

All these arrangements will be much easier, and the entire operation more readily and cheerfully performed, if the whole of the troops understand thoroughly, by previous practice, what is required, and what is its utility

Besides the precise number of workmen calculated to fill up the entire space, there is always added a good reserve (about $\frac{1}{10}$) to allow for any deficiencies when laid out, and for casualties, &c , and even should that reserve not suffice, the General Officer commanding in the trenches orders out what may be necessary from the pickets, in reserve, in camp

The working parties are laid out from the front, that is, along the parallel first, and thence to the rear along the approaches, so that any deficiency may affect the rear and part most distant from the enemy, where it is easier to be provided for

It must be expected that there will be various spots and places to cross that will present more difficulty and require more skill to complete than the rest

1 Water-courses and drains these must not be interrupted, and will require pipes or openings made up of planking or other means to leave a free passage, otherwise, it will be necessary to open them subsequently with much labour and difficulty

2 *Hard roadways, perhaps paved*

3 Buildings, walls, ditches, shrubberies or trees, &c , &c , &c

To all such places a few Sappers, or of the regular men attached to them, should be appointed, who will be properly provided with means, and will understand how to complete the line over such obstacles Where the entire of the soil is of rock or bad swamp, it may be deemed impracticable to carry on siege operations over it, in front of a garrison of any power Such ground may be passed, and even batteries constructed on it,* by the necessary extra earth or materials brought from the nearest or

* A foundation of two crossed courses of fascines will support any work on a swamp —*Editors*

most convenient place, if that part of the operation be of small extent; to assist, the trench may be widened when depth cannot be obtained

The General in command of the trenches, and the Guard, take the duty for twenty-four hours, and are relieved at mid day, the Guard being furnished by battalions, if not by brigades

The working party take the duty for twelve hours, and are relieved usually at 6 A. M. and 6 P. M.; the duty should be by companies at least, but better by regiments: in neither case by mere mixed detachments If the besieging force be strong enough in proportion to the siege work to be executed a more frequent relief of working parties would tend to the more rapid completion of the work, but the arrangements should be such as to give the troops at least three periods out of the trenches, for one in

The Engineers, Sappers, and men attached, should have three reliefs in the twenty-four hours, and at different periods from the working parties, but they will be well off if they are in sufficient number to have not more than one in four tours in the trenches

When working parties are tasked, they should be dismissed scrupulously as soon as the task is completed; and more work will be obtained, and with more alacrity and satisfaction to the men by this mode, than by keeping them lingering over the work for twelve hours There is also a great advantage in getting the work clear of these men for some time before the new party comes in; such interval is most usefully employed by the Sappers and their assistants in arranging the tools and work, and adjusting or completing any part that may be a little irregular, deficient, or exposed this is so desirable, that when the men work even *by time*, it is well to collect and retire them a full half hour before the arrival of the new party

If the working parties have their arms, and form part of the strength of the force *for resisting sorties, they must not be dismissed from the trenches altogether, till* relieved, but will be in that case only withdrawn from the work

In cases of reliefs or generally of parties meeting on any account in the trenches, the out going party invariably halts, and lets the in-coming pass

Should the opening of the trenches be decidedly discovered even early in the evening, and a heavy fire directed upon it, it can still be forced on by discipline and spirit, and without so much loss as might be expected.

The same precautions must still be taken by the Engineers to insure correct positions and lines, and in bringing the parties up. The only difference in the arrangements will be, that under such fire the workmen commence, each man as soon as placed, in order that he may be sooner under cover

The result of such a night, however, will be some inaccuracies, and some parts imperfectly completed;—reserves will then come more particularly into service, and there will be more need for the adjustments applied by the Sappers and assistants

In order to reduce the amount of duty, and the number of men in the trenches, it is the general custom now to make the working parties take their arms and accoutrements,* so as to make up with the guard the necessary number to resist sorties It is attended however, with many inconveniences The arms and accoutrements are a great incumbrance to them, and being laid on the reverse of the trench, are liable to be injured;—in case of a sortie or alarm it is not easy to get these men collected and in order, they become mixed with the guard, and hence arises confusion, nor are they easily brought back to the work

At all events, however, it is particularly desirable that the parties who first break

* Their knapsacks are left in camp

ground should not take their arms they have each two intrenching tools, and perhaps a fascine, to carry; therefore systematic exertions are required from them; and it is unusual at that period to be opposed by any great sortie

It would be less inconvenient for the morning relief to be armed, as they will have few, if any, tools or stores to carry, they can also take better care of their arms, and may be more likely to want them during the ensuing day

SORTIES

In ordinary Sieges, Sorties in much force, made upon the approaches when not less than 250 yards distant,—that is, up to the second parallel and its batteries, or farther, —can seldom be very injurious to besiegers, unless the latter are guilty of great neglect or want of caution, or have very imperfect means of protecting themselves

The garrison in making a sortie has one advantage, namely, the shortness of the distance to be passed between the first alarm, and being in contact with the enemy, so that if the besiegers are negligent, it partakes of a surprise, but that advantage is to be neutralized by the troops in the trenches being taught always to expect such an attack at any moment, and the measures to be adopted being thoroughly understood

After the French had made one or two sorties at St Sebastian with some success on a parallel at about 200 yards distance, the Guard in the exposed part of it were made during the night to sit on the reverse of the trench with their arms in their hands, in expectation of the next, and under instructions to charge the enemy the instant they should be seen on the parapet. This accordingly took place, and it was driven in at once without an attempt at a struggle, and was the last attempt of the kind

The Sortie is also considered to have an advantage in being covered by the fire from the place, but if it be advanced to any distance from the works, it will probably suffer more loss in retiring to them, than the besiegers will from the artillery of the garrison

The disadvantages of the troops making the Sortie are—

1 That they necessarily attack a superior force, probably very superior; the ordinary rule is, that the Guard of the trenches should be equal to three fourths of the garrison, it is seldom, if ever, that a sortie will be of any thing like that proportion, and the far greater number of comparatively small force

2 That they are under the moral impression that definitively they will be forced to retire, and the only question being *when* that is to take place, they must be inclined to yield to the first spirited attack made on them

3 In retiring, which it must come to, and necessarily in some confusion, the exposure and consequent loss must be heavy

4 Every loss to the garrison is irreparable, whereas the supply for the trenches is, as it were, inexhaustible, in other words, the advantage would be with the besiegers in the loss of man for man with the garrison

It would of course be of vast importance to the garrison if by sortie it could obtain possession, even for a short period, of any of the armed batteries of the attack, but such an advantage is not to be anticipated, unless occasionally, perhaps, in sieges of very large places

The principal efforts are made upon unfinished portions of work, and the success will be more likely to be effective, if such unfinished part is extensive, and consequently farther removed from support

A very short possession of parts of the trenches, lined with gabions, may cause much trouble, time, and casualties to the besiegers the gabions being overturned into the trench, and partially cut, are extremely difficult of removal, thus adding

rampart of the same Each of these batteries must have its covered approach from the parallel, and its expense magazines *

They are usually commenced on the night succeeding that of establishing the parallel, and will require great care in being laid out in the proper direction, to produce the proper effect, which in works well defiladed is not always an easy operation

Should the nature of the works of attack and of the ground admit of these batteries being applicable and efficient as the trenches advance, instead of its being required to establish others in front of the second parallel, it will be very advantageous

1. Because the work is earlier and more easily executed.
2 The batteries more easily supplied with ammunition and every necessary
3 The distance is a favourable one for the purpose
4 The Gunners less liable to casualties
5 The batteries more retired, and consequently more secure from sorties

From the period of occupation of the first parallel, every opportunity is taken by night or day of pushing on the zigzag approaches towards the next

The principal requisites of these zigzags are—

1. To be quite clear from exposure to any degree of enfilade fire from the fortress
2 To be confined between converging lines, that will not mask the fire of the batteries in their rear

They are directed on the line of the capital of the work which they are approaching, and the converging lines, above referred to, will be comprehended between the salient angle of the work, and points on the first parallel, about 70 yards on each side of the prolongation of the capital

SECOND PARALLEL.

The Second Parallel, under ordinary circumstances, is constructed at about 300 yards from the covert way, and is opened under similar arrangements as described for the first, for even at that distance its establishment can be enforced without much loss; but as the fire of the garrison is more effective, it is desirable to use gabions for it, if possible, and the workmen usually begin to cover themselves as soon as each is respectively placed

The approaches from the works in the rear must be undertaken simultaneously

Should batteries against the defences be necessarily attached to the second paralle, they will be also about 50 yards in front of it, and as described for those in rear

It may be observed, that in general, in proportion as the works of Attack become nearer, the attention of the garrison is so much called to them, that, added to the effect of the fire on the defences, great liberties can be taken in the rear, thus, when the besiegers are on the glacis, little or no notice will be taken of any ordinary proceedings about the first or second parallel, or their approaches

As the works advance, some means will be required to keep in order and repair the earlier works, but they will be small, their thorough drainage should be always attended to

ON THE MEANS OF REDUCING THE DEFENCES AND SUBDUING THE FIRE OF THE PLACE

The works of Attack cannot be carried on nearer than 200 yards of a fortress or fort of the least consideration, unless means are employed to keep down or greatly reduce its fire

Nor can the storm of a breach, on which a flanking fire can be brought, be attempted without great risk of failure, and almost certainty of very heavy loss

* See article 'Battery'

Hence the cause for reducing these means of defence: and it is well to advert to these principles, because where the necessity does not exist, the formality of the operation may be dispensed with

There was a striking instance of this in the siege of Ciudad Rodrigo, in January 1812

The part of the fortress attacked consisted of a revetted line of ramparts, surrounded by a revetted fausse braie, with a ditch and very low counterscarp, the whole unflanked, and the two escarps seen nearly to the foot, from a height within 500 and 600 yards distance

The time that could be given to the siege, before a relieving army might be brought to raise it, was short

The project was accordingly to effect a practicable breach by a powerful artillery from the height, and then to storm at once, without approaching step by step in the more ordinary manner.

Twenty six* 24 pounders were accordingly placed in battery for the purpose, and proceeded unremittingly in the work of breaching *without paying any attention to the fire of the place*, which had a good garrison and was well provided with artillery

The French Engineers remarked upon the singularity of this proceeding, but it was founded on good principles

The fire of the garrison could not check the operation of breaching

It was not the intention to carry the works of Attack very near the place, although during the operation, a small parallel was, with exertion and some difficulty, constructed on a lower intervening height, to within about 200 yards *and the breaches were not flanked*, *consequently*, *according to the project adopted*, *there* was no absolute necessity for opposing the fire of the place, and any means applied to it would have been a reduction of those for the more urgent object of breaching

The above is a very rare case, arising from defective fortification and the pressure for time

Under all ordinary circumstances of sieges it is necessary to pay great attention to the reduction of the fire of the place, and, generally speaking the result of a siege operation, as regards certainty of success, amount of loss sustained, and time engaged in the undertaking, will be dependent upon the efficiency of the means employed for this purpose If they are abundant, and skilfully managed, the Engineers progress will be rapid and easy, by day as well as by night, but it may be understood how effective the fire of the besiegers ought to be, when it is brought to mind that *the fire of the lightest piece of artillery on the head of a Sap will effectually stop its progress during daylight*

The means employed for reducing the fire of the place are—

1 Enfilading the several lines of rampart and covert way from guns or mortars
2 Ricochet combined with enfilade
3 Direct fire of artillery to ruin the parapets
4 Musketry brought to bear upon the embrasures
5 Pierriers, or stone mortars, and royal, as well as Coehorn mortars ($5\frac{1}{2}$ and $4\frac{2}{5}$ inches), when very near

1 *Enfilade*

A line exposed to be enfiladed by guns at full charges, within moderate range, cannot be deemed tenable, hence one of the earliest improvements in fortification was

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* The number varied from twenty three 24 pounders and two 18-pounders, to thirty 24 pounders and two 18 pounders —*Ed tors*

to construct the works so as to be *defiladed* that is, so arranged as that their interior should not be seen: thus they were protected *from shot*, until Vauban invented the mode of effecting the object by ricochet

No protection was afforded, however, against the effects of enfilade from mortars, either then or subsequently by the traverses, which were contrived to check the ricochet

The enfilade by mortars against uncovered batteries is very destructive.

Where fronts are well covered, an *enfilading battery* is constructed against each face or flank, &c., *requiring to be silenced*

Circumstances seldom occur of the whole front being so enveloped by the trenches as to admit of enfilading it generally; but sometimes they are so, and a considerable advantage thereby afforded.

Such a position commonly occurs from the opposite bank of a river to that on which the place is situated, where batteries are constructed to take the entire front generally by enfilade, and many of its lines, consequently, at different angles in *reverse*

If not only this advantageous position can be gained, but they can also be placed upon heights from whence the interior of the works can be *seen* although even at very long ranges, such as 1200 or 1500 yards, as at St. Sebastian in Spain, the advantage is very greatly increased

2 *Ricochet*

Is a very formidable application of artillery against uncovered lines *Even traverses* afford but an imperfect protection against it The shot ruin their interior angles, and the explosions of the shells in them act as so many mines of destruction, and as they are directed in enfilade, there are few of either but what take effect

Ricochet practice, however, is one of perhaps the greatest nicety in the Service of Artillery, and cannot be too much practised it is the more difficult to regulate with precision, as the actual course of the shot or shell in striking the object can scarcely be perceived, and requires a combination of accurate direction elevation, and charge of powder, that can only be worked efficiently by well exercised Gunners.

3 *Direct fire of Artillery to ruin the Parapets*

By the end of a siege, the parapets on the confined portion of the front subject to the last efforts will be quite ruined by the direct and enfilading fire of shot and shells For this direct fire, the nearer the batteries are to the place the better

When direct fire alone is employed against the guns and defences of the fortress they will never be entirely reduced, except in small confined positions, such as a *single flank*, and by a powerful and constant fire on it from a very short distance

4 *Musketry*

[illegible] to bear on the em-
[illegible] 0 yards, the fire of
[illegible]
[illegible] being of old construction, without salient outworks, Riflemen, Light Troops or men of the Line acting as such, were frequently dispersed at some distance in front of the parallels, in small pits dug by themselves, and by their fire kept down the artillery of the place sufficiently to enable the approaches to be carried *very close*, without employing artillery (of which there was a great deficiency) against the defences

This is a subject of boast, and a fair one, of the French Engineers

Although musketry fire has been frequently very effective, and may be so again, it can hardly be relied on with any certainty, as it would appear that many expedients might be used to screen the Gunners from its effect, while the guns are at the same time actively served. If they had even a sheet of linen before the embrasures, so as to conceal the guns from view, there must be an enormous expenditure of ammunition to keep them constantly from being served. (*See* 'Battery,' Plate II fig 6, where a hanging mantlet to an embrasure is given.) The troops employed for firing parties in the trenches are usually protected from the musketry of the garrison by sand bag loopholes along the parapets.

There is usually a very great expenditure of muskel ammunition at a siege, in some cases there may be ready means for the supply, but in others there may not, and at all events, *waste*, which it frequently amounts to, is improper.

When parties are required to keep down the fire of the place, it should not be by posting them in large numbers indiscriminately in any situation, to fire at random, but by an adequate number of steady selected men, if possible good shots placed in the most advanced and favourable points, covered by loopholes of sand bags, fascines, &c., and never firing but with a precise object and steady aim: after loading they frequently leave the musket pointed, and watch for the next favourable opportunity to fire.

A small quantity of ammunition employed in this way will have a great effect, cause many losses to the enemy, and very much reduce his fire.

5. *Pierriers or Stone Mortars and Coehorns, &c.*

Pierriers are noticed in all works on Attack as an accessory, but there may be some doubt as to any effect being produced from them commensurate with the means required for their carriage, their service, and the narrow limits in which they can be placed, nor will the proper materials for supplying them be easy to procure in many localities.

Small mortars, such as the 5½ and 4⅖ inches,* are certainly very useful, particularly if employed in considerable numbers, they are very easy of carriage, easy to supply, and can be placed anywhere: their shells, poured into confined spaces, such as the outworks of fortresses, must be very powerful in preventing any strong occupation or demonstration from the works.

As above remarked, everything that is to lead to a rapid and successful progress of a siege will depend upon the adequacy of the means employed for reducing the defences, and the energy and skill with which they shall be used.

Where they are well and efficiently applied, it is easy to conceive the state of the works comprehended within the front of Attack, ploughed up incessantly and in every direction by shot and shell,—not a place from whence a view can scarcely be taken from the parapet with impunity, the moral effect on the troops must be depressing on proceeding to do duty in such a scene, from the comparative quiet and security of the rest of the garrison, considering that it is not to a fair equal combat, which never fails to arouse the energies of the soldier, but to witness a gradual and discouraging diminution of their resources and hopes.

Even among the Officers and Commanders it will require men of peculiar energy to use very active exertions to see that every possible means of prolonging the defence

* In the article 'Artillery' Major General Lewis suggests the introduction of 6½ brass mortars (now that the 32 pounder howitzer is established) as superior to the 5½ and 4⅖ mortar though still of a size to be conveniently portable.

be employed in every part. Any weakness or neglect on the part of the Officer in command of even a small outwork may be very injurious to the defence.

THIRD PARALLEL.

After the Second Parallel, that is, within 300 yards, if exposed to a heavy fire, including grape and musketry from the garrison, the progress of the trenches can no longer be *forced* by extensive simultaneous breaking of ground; *it is then regulated* according to the degree of opposition made; whenever the garrison is inactive, immediate advantage is taken of it, particularly by night, to lay out more or less extended *lines of gabions*, and to set workmen to fill them at every opportunity: in this manner, especially at from 100 to 300 yards, the work is much accelerated.

While the fire of the place is animated, the operation can only proceed by the full Sap, but from as many heads as possible; when very near, say 50 or 60 yards of the covert-way, it is probable that the only resource will be by the full Sap, during the day; but at night, even then, there will probably be many opportunities of advancing at periods by the flying Sap.

A Third Parallel is usually constructed at about the foot of the glacis, the nearer the better; and subsequently, Demi parallels for intermediate supports, and cavaliers de tranchée, to gain a *commanding* fire into the covert-way; and even a Fourth Parallel — all according to the power that the besieged are enabled to put forth in their defence, which however must be very obstinate, and the artillery means of the besiegers inefficient, to render the two last resources necessary; particularly the cavaliers de tranchée, which are very troublesome to construct.

The nature and position of these several works will be best seen on the accompanying diagrams. Plate II. figs. 1, 2.

When the approaches are on the glacis, the enfilading batteries become very much masked, entirely so as regards their effect on the covert-way; and unless the artillery be very *ably* served, even on the faces and flanks of the works within the ditch.

At this time pierriers, howitzers, and the small mortars are established in the advanced works* to act as substitutes.

The effect of this change of system, *however*, generally favours for a time the besieged in making renewed efforts to oppose the progress of the Attack.

Portions of the Third Parallel are prepared with steps to enable the troops to march out in order, when required, either for attacking any work, or to oppose sorties Plate II. figs. 1, 3.

Formerly, the crowning of the crest of the glacis was generally forced under a heavy fire from the garrison, and at a great loss, and was then the most *delicate* and uncertain operation of the siege; but this has been since superseded by the more *effective* employment of artillery, which enables it to be gained by the Sap, and without even much delay; the mass of shot and shells dropped into the covert-way during the progress of the siege effectually ruining the interior palisading or other slight

faces of the works, and counter-batteries to destroy the parapets of the flanks, are constructed along the crest of the glacis

In some cases, where the escarps cannot be seen from that position low enough for

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* Retrenchments of slight walls, or of palisades, might have light guns brought against them, or perhaps even heavy rockets, so as to hasten their reduction earlier than could be effected by waiting to put the heavy guns in battery

breaching it is necessary to construct the batteries for that purpose in the covert-way, an operation attended with more difficulty, and leading to the artillery being in a more confined position, and more exposed to suffer from shells

During the time of constructing and obtaining effect from these batteries, the passages down to and across the ditch are made

The communications to the ditch may be made either by blowing down the counterscarp wall and forming ramps down,—or by galleries from the glacis down to the level of the ditch, made on the system explained under the head of 'Mines,' or if there are sufficient means and time, both might be adopted,—the galleries for ordinary service of the Sappers and progressive work and the open ramps for storming parties

Where it is necessary to make lodgements and batteries on the breaches of outworks, the passage across the ditch and up the breach is carried on by Sap, full or flying, according to circumstances

Though the besiegers are, in these latter operations, advancing in confined spaces, and with narrow fronts and little cover, still their position is so commanding from the crest of the glacis, the covert way, and the outworks —as in succession they become possessed of them, and the garrison of each work attacked consecutively —so confined for space, and either so weak in numbers, or if otherwise, so exposed to the vertical fire, while timely support is so difficult to be given them, that the result is usually a question merely of time.

The passages across wet ditches must be made by filling them up for the necessary width and height, the rubbish from the breaches and from the communications down to the ditch tending towards them the rest is either of fascines or earth

Where there are running streams through a ditch it will be necessary to leave sufficient openings for the current by a connecting trestle bridge, or perhaps side channels may be possible, to afford another course for the stream *

According to the ordinary modern system of Attack, it is seldom that any Assaults are made than the final one for taking the place, but the breaches are successively occupied, and lodgements made on them by the Sap

The exceptions are, where a work being once taken is irrecoverable, such as enclosed detached redoubts, or outworks, which can be assaulted while their communication with the garrison is cut off or rendered too difficult to be re occupied

In the first case, the redoubt is, as regards the effects of an Assault, reduced to its own isolated means, in the second, the possession of the work will be in the hands of that one of the contending parties which has the easiest communication to it thus an outwork that is under the fire of the place, and not breached cannot be held by the besieger, nor can one that is breached, and without an intrenchment perfectly closed against a coup de main, be held by the garrison

An intrenchment connected with the parapet of a work is no security against an assault, as it will be turned by the parapet, and its garrison driven out with loss

It does not follow, that because an outwork is taken by assault, that it will continue to be occupied under the fire of the place, the object will be to drive the garrison in from the immediate propinquity, while the communication to the work, and lodgement on it, shall be made secure

The final Storming of the Fortress takes place when the breaches are practicable, and there are no obstacles left that can, in the judgment of the besieger, prevent his masses of troops penetrating completely into the place

The assembling situations for the storming parties and supports are arranged, and

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* Colonel Blanchard's Infantry Pontoons must now be the resource for crossing wet ditches —*Editors*

be employed in every part. Any weakness or neglect on the part of *the Officer in* command of even a small outwork may be very injurious to the defence.

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The garrison being driven from the covert-way, the breaching batteries against the faces of the works, and counter batteries to destroy the parapets of the flanks, are constructed along the crest of the glacis

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the communications from them to the breaches, or points of attack, made amplé and good

As great a fire of artillery as possible, particularly from mortars, is concentrated on the breach and interior of the work, immediately preceding the assault and as much as practicable during its continuance, to derange the means of defence, not only the bodies of troops of the garrison, but with the chance of obtaining the premature explosion of live shells, powder-bags, &c, prepared for defence, as occurred at St Sebastian

After the works are gained, and the town, or interior of the Fortress opened, the storming party and supports are re formed, and directed in the manner best calculated for securing the garrison, or driving them into any citadel or interior hold, till when the operation must be deemed incomplete

This is particularly necessary for Night-Attacks, and more especially for the Assault of a Fortress by a coup de main

In the latter case, if the garrison can rally and repel the assailants, the entire object is defeated, as occurred at the storming of Bergeo-op Zoom, by the British forces, in 1813

At all Assaults, the main body is always accompanied by at least one Officer of Engineers not merely to assist in stimulating the party to actions of vigour, although they usually do not fail in that respect, but to afford the advice to the Officers in command which he is enabled to give from his superior knowledge of the nature of fortification, the combination of the several works, and generally of the resources of attack and defence *

It is usual in Assaults for the advance, (or forlorn hope,) conducted by the Engineer, to precede the main body by, perhaps, 20 paces The support follows the main body at, may be, 100 paces.

This Article has been written entirely with reference to the principles of Attack of Fortified Places, as they existed up to the termination of the last great continental wars

Since then, new and improved systems of fortification have been adopted to remedy the ascertained defects of the old ones, and several have been, or are now, in course of construction, which will hereafter require an alteration in Siege operations suited to the changes in their trace

These new principles of fortification have not been sufficiently classified or analyzed, to enable any decided view to be taken of the manner in which it will be expedient to attack them.

Where they are small, it is probable that in removing some defects the constructors will have fallen into others, of which the besiegers will be able to take advantage

Where the fortresses are large, (which is the more common case,) the very size, when properly garrisoned, rendered in former days the siege of them at any time so difficult, that it may be reasonably supposed that the exhausting of all the resources of the Engineer's art and the expenditure of very large sums of money upon them, will have rendered them almost impregnable.

At all events these new fortresses are not common, and for one that will have to be besieged, there will be twenty on the old systems, and for which the present principles of Attack will have to be applied

J P B

* See Assault,' page 116 —Ed for

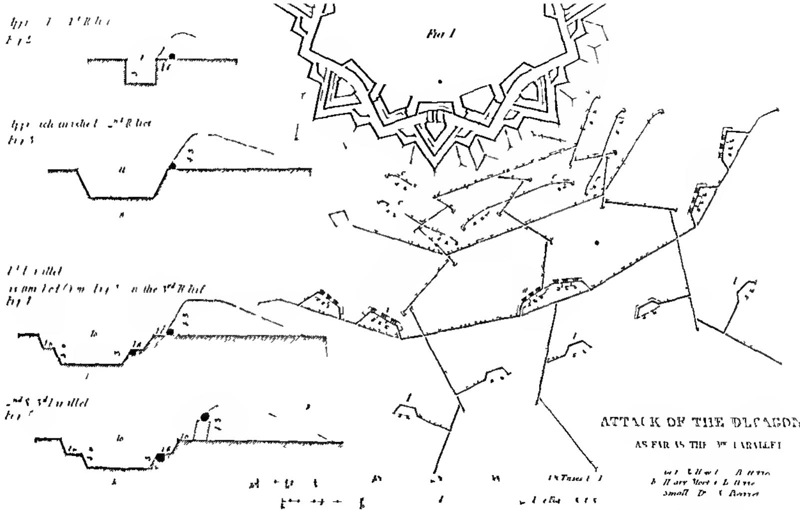
Fig 1
ATTACK OF THE POLYGON
AS FAR AS THE 3rd PARALLEL

ATTACK OF POSTS.*

Temporary works may be attacked by stratagem or by open force; but it will be necessary to obtain accurate information on several essential points before a decision can be made as to what course will be the most judicious or practicable under the circumstances. For instance, previous to making any dispositions for an Attack, either of a village and entrenchment, or a small military post, a Commander should have some knowledge of the locale, the nature of the defences, and the strength of the force occupying them. It should be ascertained whether they are left to fight their own battle, or are in a situation to receive support, and from whence that support is to come—how the duty is done—what is the nature of the ground around it—whether favourable for concealment or otherwise—which are the shortest and best roads to it, &c., &c.†

If an intrenched village is to be attacked, it should be ascertained by what means the streets and roads leading into it have been closed—whether by stockades or breastworks—how these obstacles are flanked—whether from neighbouring houses or temporary works thrown up for the purpose—what obstructions are placed in front of them, whether abatis or trous de loup—how the houses forming points in the main enclosure have been strengthened—whether there is a keep, and of what nature it is—and how fortified—whether there is any building occupied on the outside as an advanced post—where the pickets are placed, &c.

If the Post is an isolated building, such as a country house or church, attention should be directed to the mode in which the doors have been barricaded, or the windows blocked up—how the loopholes are arranged—what sort of flank defence has been obtained—how it can best be approached—what internal preparations have been made for prolonging the defence, &c. Part of this useful knowledge may be drawn from spies, deserters, and maps, not however trusting any of them much further than they can be seen or verified; and for the rest there is nothing comparable to seeing for one's self, and therefore even an open reconnoissance or a secret peep must somehow or other be obtained.

These hints will suffice to shew that there are a multiplicity of objects which require to be looked to before an opinion can be formed as to the best course to pursue; and unless some previous information is obtained upon some or all of them, false calculations will necessarily be made, unexpected obstacles will be encountered, and hazardous enterprises will be undertaken, all which might at least have been modified. With superior numbers in hand, and no very great show of opposition in front, it may be difficult to exercise patience, and just to find out what one has to encounter both before and behind the little level lines of parapets and palings. There may be some great yawning ditch either to you or from you, which it is not so easy to take in your stride. All things are not always quite so smooth as they look: it is therefore better to find out if you can, and prepare accordingly.

The dispositions for the Attack of whatever nature it may be, though they require to be made with great circumspection, and executed with the utmost celerity, decision, and effect, do not perhaps call for so many precautions as are necessary for the defence of a work. It is with the assailants to choose what they will do—with the *defenders—on very short notice, to conform* and *make the best of it*. The *first* object of an Attack is to get—*at* the people who are defending a work, and then—*to beat them*. To secure the *former*, a Commander would naturally seek for a point which presented the fewest obstacles, and when he saw where to strike the blow, he

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* By Lieut.-Colonel Jebb, C.B., R.E.

† See Plates on the Defence of Posts in this Volume.

would accomplish the latter, by hitting 'uncommon hard,' so hard as to make his adversary reel under it, if it did not knock him head over heels, and get rid of him altogether These main objects being kept in view, everything that would conduce to secure them must be studied and carried into effect. He would therefore arrange his plan with the utmost caution, and execute it with corresponding vigour It will be obvious, that where it is practicable, several real Attacks, or one *leviathan* and *several false ones, will distract an enemy's attention,—divide his forces,*—tend to disturb him and shake his confidence,—render his combinations more perplexing, and, in short, give him more to attend to, with diminished means of doing it, than if one Attack only were made It is usual, therefore, where circumstances permit, to attack several points at the same moment, or in quick succession To effect this, the columns are formed under the nearest cover that *can be found, from which they* advance with as much celerity as will leave the men *fresh* when they get to work. To regulate even this properly is a point of no small importance;—for instance, if a column has any considerable distance to move, in the face of a smart peppering fire, and they start at too great a pace, they may be brought to a stand-still before they can close with their opponents, and that too when the fire upon them, from its diminished distance, is the more deadly The means of moving *powerfully and swiftly at the last* must be preserved at all events This forward movement is covered by Light Infantry, who would halt on the outside of the ditch or other obstacle, and whilst the column was engaged in getting over it, would endeavour, by good steady shooting to aid the operation in keeping down the *enemy's fire*, or *putting down any overt acts of opposition on the part of the* defenders. It would be a weak proceeding to permit any of the men *in the column* to amuse themselves by firing, and, to prevent disappointment, it might be explained that they have much more serious business to attend to with the bayonet, and till that is done, they should think of nothing else Any little *decided leisure* might be so employed by a few of the leading files being disposed in front for that purpose, whilst the others were lying down to cover themselves, but the main point should never be lost sight of, no time should be wasted upon it, for the assailants and defenders, under such circumstances, are far from being on equal terms, the former being exposed from top to toe all in the open, and the latter at the worst would be covered up to their chins

Each column designed for making an Attack is usually divided into two parts, the relative strength of which must be determined by the nature of the operation —the number of the defenders,—and a train of probabilities too long to be enumerated here One party is *for storming the work*, and the other is placed in reserve to be applied as events turn out, either to assist *in following up and taking advantage of success, or as 'a friend in need'* to fall back upon, in case of disaster The former of these parties may be again subdivided into two or more parts, one for the first onset and the others *for support*; but this should be more *nominal* than *real*. The question is, shall we send the whole storming party on, in one mass, or shall we first *start* it in separate detachments, and then let it *finish* as one mass? We require the moral as well as the physical effect which NUMBERS will produce, in order to penetrate the enemy's line, but if we can secure *those essentials when wanted, it does not appear* necessary to expose the support or the *tail* of the column, whilst any work is going on which the *head* of it, or the real storming party, can effect just as well by itself. For instance, there would be little good gained by a vast body of men being halted under a close fire, whilst workmen were engaged in cutting a road for them through palisades or an abattis, or whilst the leading files were rearing ladders for an escalade &c The *moral effect* and confidence produced by *numbers* which it is most essential

to study, would be still retained if the *head* of a column could feel assured that it travelled with its *tail* on, though it could not see it, and that however fast the one might move, the other would be certain to follow: and the *physical effect* or *force* that is required for an onset would be equally secured by the same means. Numbers are in either case the chief ingredient; the only thing to be considered is the proper application of them. This is confessedly rather a nice point to manage, and such as it is more easy to theorize upon than to carry into effect; but if troops are handy, and are accustomed to work together, and to be *sure* of each other 'in sight and out of sight,' and their efforts are directed by the hand of a master, there do not appear to be any impossibilities attending its adjustment, at any rate the principle, if true, is not falsified because the practice is difficult. In Night Attacks, for example, it is especially necessary that all the arrangements should be the simplest possible,—and under such circumstances an undivided force would be preferable to risking a mistake being made in the administration of separate parts of it.

In carrying out the principle of the storming party and its support marching separately, we ought to find that as the leading files of the former became engaged, or as the explosion took place which was to blow the barrier to atoms, by which they were to enter a work, the supporting column should be close at their heels,—to add their weight to the first shock,—to inspire confidence,—join in the cheers,—and be at hand to rectify anything that might happen to go wrong. These little *delicacies* cannot be brought within the precise limits of any rule which shall be of general application, whether as respects distance,—or time,—or pace,—or anything else. It is the Commander who has the right kind of head on his shoulders, and an eye that is good for something in it,—who can alone apply the principles, and regulate them on the spot.

Troops aided by musketry in the manner adverted to, would plant ladders for escalading,—Sappers would cut away palisades,—blow open barriers or gates,—make steps in slopes that were too steep to be ascended, or clear away impediments, and a steady charge would then take place. Not one man running at the top of his speed and another after him,—that is not the way to get rid of a set of resolute fellows. It must be a steady charge, or rather a quiet determined rush, the whole weight of the column is wanted to make the desired impression on the adversary's line, and if it is frittered away bit by bit, much of the effect is expended in individual acts of heroism, which might be more usefully employed. Where several attacks are made, the columns may as well all march on the same front, in subdivisions, or a greater or less formation as might be convenient, as it will make it more difficult for an enemy to estimate numbers, or distinguish the real from the false attacks; and the latter should look and act as if they intended mischief, however innocent their designs may be. They should also be of such a strength as to command respect, in order that they may be in a condition to profit by unforeseen success: the *number* of attacks should therefore be in proportion to the force that is to be divided. How frequently has it happened, that a false attack which would have been considered as too rash and hazardous an enterprise to be thought of seriously for a moment, has been crowned with a success which has equally astonished friends and foes, whilst others which have been judiciously planned and organized have altogether failed!

It is explained further on, that the 'top o' the morning' is not a bad time for making an Assault; this is chiefly because the previous movements are concealed by the darkness, and the loss is diminished in proportion. For instance, under favourable circumstances, it would be quite possible, after driving in an enemy's pickets the preceding evening, secretly to dispose a firing party close to the ditch on the outside

HOW TO DEAL WITH AN ABATTIS.

An Abattis is probably the first obstacle a column will fall in with, and an awkward obstruction it is, if it has been properly managed, and the materials have been of sufficient size and weight. In an Attack by surprise, an endeavour should be made to get round the flank of it, and if that 'wo'n't do,' the men must try and crawl through it in the best manner they can, avoiding any noise, and forming again as they succeed.

If the Attack is by open force, and the abattis should prove impenetrable, there is no harm in making the attempt to set it on fire. A few resolute fellows, carrying small fagots which have been previously dipped in pitch, and each man provided with a 'lighted portfire,' if it is day-time,—or if they can approach unseen by night, with some other means of setting fire to them,—must rush up from some neighbouring place of concealment, covered by a smart fire of musketry, and throwing in their lighted fagots, all will soon be in a blaze When that has subsided, and there is no fear of the men's pouches being exploded, the breach will be practicable, without waiting for the hot cinders to cool. This little conflagration would go on under the protection of a party, near enough to prevent any attempt on the part of the defenders to extinguish it. If, however, an abattis is formed of small materials, or if sufficient precautions have not been taken to secure it in its place, (that is, if it is *a bad one*,) it will be a waste of time to submit to the delay of burning it. in such a case, a party rushing up with ropes may tie them to some principal trees, or a big hook fixed to a rope or pole may be used, and a tree or two may by these means be dragged forcibly out of the line, or some handy fellows with good tools may partially open it, by cutting away a few of the small branches, so as to let men get through at 'open order.'

HOW TO OVERCOME OTHER IMPEDIMENTS

If the obstructions outside a Post consist of military pits, stakes, or the stumps of trees, &c, they may be passed at 'open order,' if they cannot be avoided, and the columns be re formed as soon as possible Small ditches may be filled up with fagots or bundles of hay,—chevaux-de frize may be displaced by main force, with a rope and a good pull altogether,—or they may be cut up or blown to pieces with a bag of powder, palisades, or fraises in a ditch, may be got rid of in a similar manner,—or if a party is provided with ladders or planks, and the ditches are narrow, these last obstructions will frequently offer facilities for constructing temporary bridges for passing over them Stockade-work or palisading may be escaladed with ladders brought up in a line under the protection of a firing party, and carried by two or four men, according to their length The ladders should be planted as close together as they conveniently can be, and the assailants should mount them on as extended a

match for any of the ordinary obstructions which might oppose their advance, whether the attack were made by night or by day, by surprise or by open force

OF ATTACKS BY SURPRISE

A Post is said to be *surprised* when an enemy either gets into it, or close up to it,—by making a false or forced march, information of which has been concealed from the defenders, either by their own bad look-out, or their opponents having been favoured by fog or darkness, &c ; or it may be that they have succeeded in quietly cutting off some advanced Post, which would have given the alarm

When ably planned and carried into execution, a surprise is the best kind of Attack

that can be made; there is less expense of life entailed, and from being unexpected, there is, from the nature of things, more confusion among the *defenders*, and therefore less resistance afterwards. The result also is generally more decisive, and smaller numbers can act with far greater effect against a superior force than can be hoped for in an open Attack. It is only, however, when an adversary fails in his precautionary measures that success can be confidently anticipated, even from the best framed schemes of surprise; and even then, without precise information as to the nature of the defences,—the strength of the defenders, and their measures of security,—without ascertaining the *degree* of caution and punctuality with which the duties are performed,—any attempt at a surprise would most probably fail.

Neglect in the *external* precautions of security, such as a faulty disposition of the outlying pickets and videttes,—the omission of patrolling, &c., admits of a surprise; and an absence of judicious *internal* arrangements will *facilitate* it. The first will consist in placing but few pickets, and those at too great a distance from each other, and too far to the front, so that the chain becomes unconnected, and the communication between them is not properly preserved; or in falling into an opposite error, of placing them so near to a Post as that they do not secure sufficient notice of the presence of a hostile force, to enable the *defenders* to stand to their arms; or it may be traced to a slovenly manner of carrying on the outpost duty generally. The second will depend upon the *degree* of discipline and zeal prevailing among the troops generally, and the dispositions that may have been made *for* applying their services in the most effective manner, and in the shortest possible time, &c. The following are likewise circumstances that will favour this mode of proceeding.

When there is a wood or ravine within a moderate distance of a Post,—when you have the *power* of *secretly* assembling a force equal to the undertaking which was before dispersed with a different *object*,—when the defenders think themselves in security, either from your distance or other causes, and are therefore less on their guard, and less vigilant,—*if* the Post is not quite complete in the works designed *for* its *defence*,—*if the troops* are raw, and their chief not much better,—*or if* from being deemed inaccessible, when that fact is fabulous, any part is not so well guarded as others,—these are all very tempting circumstances to try one's luck at a surprise.

Secrecy is the soul of a surprise, and as a secret is liable to '*fructify*' when in the hands of many, the less that is said about any intention of beating up a neighbour's quarters the better. Your enemies must, of course, be deceived, or kept in ignorance, and until the moment when their exertions are required, it would be quite as well for your friends to be so too. The requisite preparations therefore in collecting ladders, tools, &c. should be shielded under cover of being for some other distinct operation, and plausible excuses given forth to allay suspicions as they arise.

Among other considerations, it will have to be decided beforehand whether the Post is to be held and defended, should it be taken, or whether it is to be destroyed or abandoned. In the former case, a temporary supply of provisions and ammunition should be thought of; in the latter, the attack and retreat only have to be provided for.

Winter is the most favourable time of the year for attempting a surprise. Sentries are not usually so much on the alert in cold weather, and the long nights and the storms and fogs, which prevail at that season, are all 'accessories before the fact.' A night when the moon sets just before you want to begin the Attack is advantageous, as the previous movements will have all the benefit of the light, and the succeeding darkness may serve an equally good purpose.

It is generally admitted, that the peep of day is, under most circumstances, very favourable for making an open Attack, when there is not light enough to betray the

advance, or any of the preparatory movements, and the assailants have the advantage of daylight immediately after to profit by success, in securing all the advantages they may have gained. But an enemy knows this as well as anybody else, and the whole disposable force of an army or garrison is generally under arms at that time, and probably more on the look-out than at any other hour of the twenty four. This, therefore, is not the best time to catch them unprepared, and it would appear, that getting up a little earlier, or sitting up a little later than one's adversary, would afford a better opportunity. As to time, therefore, soon after midnight would probably be the hour, and if it could be made to square with the object in view, which may vary with circumstances, it would probably be as favourable a time for the attempt as any other: for example, if the Post were at no great distance, and the intention was to destroy and then abandon it, before *succour could arrive*, a *better hour than midnight* could not be selected, as it would afford the opportunity of accomplishing the object, and making good the retreat before daylight. But if the Post were to be held afterwards, the dawn of day immediately after the assault would enable a party to make better arrangements for defending itself, and a later attack would therefore be preferable.

From these considerations it will appear that a surprise, whether early or late, generally entails a Night Attack, and it is scarcely necessary to say that the greatest precautions, and the very best arrangements, are required for carrying it into effect, nor can success be reasonably looked for without them. The worst of going to work in the dark is, that unless the point to be attacked is of a nature not to be mistaken, it is ten to one the attempt to identify what is doubtful will disclose all. Nothing can be worse than having to poke about, especially if you don't want to be found out, which is rather an essential in a surprise. Again, when you have forced an entrance, we will say into a village, unless you are perfectly acquainted with the interior and familiar with every object that presents itself, there are other and great disadvantages *to contend against*. The *local knowledge of the defenders* is all *in their favour*,—the offensive cannot be continued with vigour, and nothing is gained in furtherance of your object by standing still. Dangers are magnified in the dark, especially when men are not excited; and as a resolute enemy will know exactly where to strike the blow, and you can neither see from whence it comes, nor estimate its force, till you feel its effect, it may become necessary to assume a defensive attitude: and this, under the circumstances, may lead to a reversal of your previous success. If there is work to do with the shovel and pickaxe, such as effecting a lodgement for establishing yourself on the ground that has been gained, or for other purposes, the darkness is favourable for the execution of it; but this does not affect the present question. Under any circumstances, however, the value of the local knowledge, which is conspicuous among the useful items adverted to, will be apparent, and with other hints which have been thrown out, will serve to create a suspicion that there is something for a Commander to think of, before he makes up his mind to commit himself in action.*

The number of men for an Attack ought, under most circumstances, to be superior to the force of the defenders, which it must not be forgotten have the 'vantage ground; but in a well conceived and vigorously executed surprise, very inferior numbers, profiting by the confusion and astonishment which are inseparable from an unexpected Attack, have done '*impossible things*,' and doubtless can do so again, which it is as well to remember when any similar opportunity should happen on service: generally,

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* Surprises in the open day can seldom be successfully undertaken except in mountainous countries intersected by ravines and hollow roads, &c.

to the defenders; and in the latter, as the force is more divided, there should be a proportionate increase, that is to say, the numbers engaged in the three Attacks should be stronger than the garrison A part of the force engaged in the false Attacks, or a portion of the reserve, should be placed not very far from the entrances to the Post that are nearest to the point where the real Attack is going on These may be streets, roads, or gateways, &c, and they should be watched, that advantage may be taken of their being turned or opened, some workmen, who are 'good at need' for breaking open barricades, being held in readiness to accompany the party

When all these particulars had been arranged and the Officers or Non-commissioned Officers commanding the several parties had been made clearly to understand their orders, and the specific objects confided to them,—when the conduct they should observe under every emergency, both during the Attack, and in the event of success or failure, had been explained, when the precise moment on which the Attacks should take place was perfectly understood,—and some conventional signal, countersign, or badge had been established by which men could recognize each other in the dark,—the columns would be in readiness to move on The advance would be made in silence, and without haste; the columns dividing when they got near the place, and marching by the best route to their points preceded by a few steady soldiers as an advanced guard, who would be on the look-out to secure any patrols or videttes they might fall in with, so as to prevent their giving the alarm

OF THE ATTACK

If the object of a column were to assault a field work, which has usually a ditch bounded by slopes of earth, the advance of the storming party would silently slide down into the bottom of it, and if there were no obstacles, such as palisades &c, and the slopes admitted of their scrambling up, they would form in the bottom of the ditch in subdivisions, or sections, as might be ordered, and endeavour to go up together without straggling, the remainder of the party following them as closely as possible, the support being halted at the edge of the ditch, ready to fire or advance, and the reserve being posted further off

If there were unforeseen obstacles, which could not be got over or removed without the noise of workmen, the secrecy of the operation would be nearly over, and it would be time to awaken the astonishment of the garrison. A few preparations being made, such as the storming party lying down opposite the spot, and the support or firing party on either flank ready to keep people off the top of the parapet, the workmen would glide into the ditch, and first distributing themselves judiciously, and finding what was to be done, and the best way of doing it, they would commence work together, and regardless of anything that might happen, would lay about them till they had accomplished their task, when the assault would immediately be given, and the endeavour made to charge in column, through whatever force was formed for the defence of the parapet when this was accomplished, a halt would be made, to re form for further operations in following up the advantage gained.

After troops once move forward to the assault, the bayonet should be called upon to do all the work, very little is gained by the leading files firing down upon the defenders from the top of the parapet, especially in the dark or the grey of the morning It has only a tendency to check their speed at the moment it is of some use to them The assailants are at that time exposed, and perfectly visible against ... first man ... there- ... in out

weighed by the inconveniences that would be entailed. It is usual, therefore, to make use of the bayonet only on these occasions.

If a wall, or any other obstacle of a moderate height, had to be scaled, the ladders would be carried by the advanced party, who would plant them side by side, and after its being ascertained that all were properly in their places the troops would advance up them in the most compact order, and on as extended a front as possible, and jumping down inside, would form again and move forward, as soon as circumstances permitted. Stockade work might be scaled in the same way.

BLOWING OPEN BARRIERS, &c.

In the Attack of gateways or houses, if secrecy is preserved till you get close to them, it is as much as can be expected. In order to force the barriers or doors, the most effectual agent is a bag of gunpowder. A bag containing from 20 to 30 or 40 lbs., according to the expected strength of the obstacle, and furnished with a fuse for firing it and a loop to hang it by, can be easily nailed or hooked up against a pair of gates or fastened to a barricaded door. If it can be done without previous discovery, so much the better, and for effecting this, a gimlet will be found a very useful, quiet operator. When fixed the fuse is lighted, and the man retires a little. The party for forcing an entrance may be drawn up within 15 or 20 yards, and a few expert men with axes and sledge hammers may be with them. The explosion will most probably do all that is required, and the ruins, if any remain to impede the advance, will quickly be got rid of by the workmen. If all this has been done in secret, it will be a great object to take advantage of the bustle and confusion that will ensue, by making a vigorous Attack. If, however, the secrecy of the operation is at an end before the bag is fixed, and this has to be effected by open violence, in spite of what may be attempted to prevent it, the best proceeding is for a strong firing party to rush up, and throwing themselves under any cover that might offer, to reply to, and endeavour to subdue, the fire that defends the point to be attacked, and when that slackened, the men with the bag of powder should make a run of it,—fix,—light, and 'be off.'—See article 'Petard.'

SECURING POSSESSION OF A POST AFTER A SURPRISE.

In the Attack of a village or even a smaller Post, the moment an entry is made a portion of the force should be detached to endeavour to communicate with the other Attacks, if there were any, and leaving a party in reserve at the point where they came in, they should secretly march, if the alarm had not been given, to secure the guards and principal avenues into the village. By thus gaining possession of the barricades or gates they would be enabled to open a communication by which a portion of the reserve, which should have been previously held in readiness, might enter. If they were discovered, and the garrison were assembling to oppose them, the same measures would be of advantage, and no time should be lost in also making a furious attack on the main body wherever it might be forming, taking care during the advance, to secure the means of an orderly retreat. The value of *local knowledge*, indeed its absolute necessity, is again apparent, for how could any of these steps be taken with the promptness befitting the occasion if this were wanting?

OF ATTACKS BY OPEN FORCE.

An Attack by open force is imposed when something like the converse of all the circumstances that would favour an Attack by surprise exists,—such as the ground outside a Post affording no cover for approaching it,—or when a Post is so well and

so vigilantly guarded that it becomes a measure of necessity, from having no choice left between an attack or a retreat, as might happen in a general action,—or an attack of this nature may be undertaken with confidence when the works are weak or unfinished, and where there are facilities for enfilading its principal lines with artillery,—or when a Commander is known to be timid

Most of the information required for judiciously planning an Attack by surprise will be also of essential service when an Attack by open force is contemplated, in either case it is equally of importance that a knowledge of the locale should be previously obtained, and that the obstacles to be overcome should be carefully estimated, and compared with the means proposed for surmounting them, before troops are committed in the attempt something must of necessity be left to chance and good fortune, but not too much If a choice exists as to time, or should it so happen that circumstances permitted a force to evade any previous exposure, by attacking in the night or before daylight, so much the better; but if the Attack is made in the open day, and there is neither natural nor artificial cover to favour the enterprise, the strongest and most energetic measures should be adopted to control or subdue the fire that would be poured in upon an advancing column, which is the worst treatment it has to endure, because it is in no condition for making a reply 'in kind' When the leading files get within arms' length of the defenders, an exchange of blows may take place, but not before,—hence the advantage of a 'cloud of light troops,' or of a strong firing party, for the specific purpose of protecting columns engaged in the attack of works, of whatever description they may be

Though there is a great difference in the two modes of Attack under discussion, because in one it is assumed that an enemy is half asleep, and in the other, that he is on the alert, and that all the means in his power will be developed to oppose it, yet in their *principles they are the same*, and as a notion of these principles and of further details may perhaps have been obtained from the preceding pages in which they are treated of, a repetition of them would be superfluous

The points requiring attention and the dispositions to be made after a successful Assault have also been glanced at, and equally apply to the more open mode of Attack under consideration But as an enemy will be better prepared for making resistance, the measures will require to be of a more decided character, and no time should be lost in following up the advantage of a first success A reserve would be left at the point where the entry was effected, and according to circumstances strong detachments would be sent off to the right and left to follow the enemy and sweep the interior of the defences, leaving guards at every entrance of a street, road, or alley, by which they might be cut off The gates and principal avenues opening towards the side attacked would be seized and access given to troops from the reserve which should be held in readiness to enter, and an impetuous attack would be made on the main body as soon as a sufficient force was assembled. If there were a keep the Attack should threaten the communication with their stronghold, and if circumstances permitted a rush should be made to cut off their retreat to it, or to *intrude*, by joining the party and going in with them —See 'Assault'

ATTACK OF AN INTRENCHED VILLAGE

It is sufficient to give a few practical observations upon the mode of attacking the chief works in which we may suppose the strength of an intrenched village to consist, which will bring us in contact with fortified houses, or churches —redoubts —fleches —or other earthen works, some or all of which may flourish as *independent posts*, or form part of the contour taken up for the defence See Plate of 'Defence of Villages'

ATTACK OF FLÈCHE, OR EARTHEN-WORK, OPEN IN THE REAR—A REDOUBT, &c.

All detached works, of the nature of a flèche, that are said to be open in the rear, are usually so far closed that they have at least a good palisading and barrier gate to shut them in; *en route*, they are generally earthen-works, having ditches of a breadth and depth varying with their importance, either revetted or finished in slopes, with a palisade in the bottom. The rear, however, is generally the weak point, and it is left open in order that it may be defended from some other work which sees into it. To assault such a work, if it is of considerable size, several columns of attack may be formed; the principal one, however, should be directed upon the weakest point, and it should be held in reserve, and if possible concealed, until the threatening attitude of the other attacks (which may be directed on the salient or the extremity of either face) shall have induced a corresponding disposition of the defenders; it may then come on in all its glory, and make short work of the palisade by some of the means before described, the other columns acting according to circumstances. If it should so happen that it was not expedient to attack a work of this description by the rear,—the general plan of operations would be reversed, and a show would be made of attacking that point, when in reality the principal effort would be made on the salient angle, or some other part, by a column kept out of sight until the attention of the defenders had been previously engaged.

If the ditch of a flèche or other outwork is bounded by walls, an escalade with ladders becomes necessary, for it is a long business filling up a ditch with bags of hay or anything else, a dangerous one to jump into it when deep, and an impossible one to get out of it when you are there, unless the retaining walls are very insignificant indeed. If the ditch is not revetted, but still the slopes of earth are too steep for men to scramble up, ladders applied to them will answer the purpose admirably, and if ladders are not to be had, rough steps may be made by workmen accompanying the columns; all these operations being under the protection of a strong firing party.

If artillery forms part of the force, a breach in the parapet may be made with shells, if time enough can be devoted to it, and the opposite ditch being enfiladed, to destroy the palisades, &c., a column has only to wait for a signal to rush forward when these objects have been accomplished, but even in this case, with everything made so smooth, a false Attack, by distracting attention, could not fail to have a good effect.

The Attack on a redoubt, which is a work enclosed all round with a parapet, and supposed to be everywhere of equal strength, will be much the same as that of a flèche. The angles are the weakest points, and the attacks, whether false or real, should direct their march upon them.—See Jones's 'Sieges' and 'Attack of Fort Picurina.'

ATTACK OF A FORTIFIED BUILDING.

The planning and execution of an Attack on a small Military Post, such as a fortified building, will more generally fall to the lot of a young Officer than the comparatively larger operations against a village or redoubt, &c., but however small the Post may be, if it has been judiciously strengthened and is ably defended, there is opportunity enough for the exercise of both talent and bravery in assaulting it. But let us have a fair fight with no artillery on either side, so that we may see what has to be done, and how certain difficulties which are peculiar to the nature of such an operation are to be surmounted.

First of all we will suppose that with the aid of a good telescope he has made him,

self, and those under him, well acquainted with at least the nature of the *external defences*, &c His points of attack are selected, and we will imagine that the little garrison is on the alert as to his intentions, and on the look-out to receive him, moreover that he has a fine sunshine to enliven his proceedings He divides his force and forms his columns of attack, and the first onset is made on the principle and with the precautions already explained We will suppose, too, that the obstructions on the outside are surmounted by some of the means detailed in the preceding pages, but here is a great staring house now before him, barricaded and loopholed from top to bottom, and full of people, and a very serious and inhospitable looking thing it is! If an Officer had not been able to procure accurate information of the mode in which this citadel of the post had been prepared for defence, or if he had not sufficient knowledge of localities to enable him to arrange the whole of his plan of operations beforehand, it would be better for him, after a successful attack on the external defences, to throw his force under any cover he could find for a few moments, whilst he took a glance at the remaining works, and was making up his mind what was best to be done, otherwise he would have to risk a wild and uncombined attack, which would probably entail considerable loss, and might be a failure It would therefore be his object, if possible, to reconnoitre* the house all round; but should circumstances induce him to decide on directing his principal attack against some part that he could see from the situation he had first gained, he might take his chance in trusting a false attack on the rear, and leave it to be worked as seemed best for diverting the attention of the defenders We will suppose that he is opposite an angle of the house, and under cover of some object within 50 or 60 yards of it, and that a little slope in the ground conceals his men when lying down He observes that one side of the house is flanked by a window, and some loopholes which have been made in an angular portion of the same building, and that on the other side there is a door in the centre covered by a tambour made of rough logs of timber set upright, the windows on both sides are low, but a ditch has been cut in the front to give height, and they are well barricaded with stout timber, loopholes being left for firing through He has brought with him six ladders 12 feet long, two bags of powder with fuzes attached, and some good workmen with axes, crow bars, &c, besides a small reserve, to apply as circumstances may require

He observes that if he rushes up in the first instance, directly for the angle of the building he will be less exposed to fire than if he faced either side, and he decides that this shall be his line; and as strong measures on these occasions are greatly to be commended, he makes up his mind to expend the two bags of powder, one in breaking up the tambour, and the other in blowing open the barricaded window,—then to effect an entrance by means of his ladders, through the window, and to force the door within the tambour by a liberal use of sledge hammers and crow bars

It is of course a great object not to expose men to fire, unless their presence or services can secure some corresponding advantage He therefore determines only to send those men forward, in the first instance, who will be wanted for fixing the bags of powder and firing them, and a very small detachment to protect them during the operation by watching any particular loophole To provide against accident, he tells off two men to carry each bag, and two others with lighted portfires for firing them, each party to be accompanied by six men, so that any loopholes which bear upon the situations where the bags are to be fixed may either be silenced or at least have their attention distracted. The success of the operation appears to depend greatly on the adroitness of the men who have charge of the powder, and he therefore has selected some smart fellows who know what they are about, and points out to them what is to be accomplished,—how it is to be effected —and what particular duty each has to

perform The columns of assault, too,—the firing party, and a reserve to protect the flanks, or fall back upon in case of accident,—would all be told off, as well as the party for the false Attack; but no movement should be made till every thing was in perfect readiness He would then explain the general plan of the Attack, and point out the position of the reserve and support, &c; after which the detachment for the false attack might move off, going by the least exposed route to the rear of the building

A favourable moment would be chosen for commencing operations If there were any cover at all, the firing party might quietly distribute themselves opposite the two sides of the house to engage attention, rather than with any hope of doing damage, for loopholes are so narrow that it would require very good and very steady shooting to fire into them from such a distance as we have supposed

The bags of powder would now be despatched;—the two parties would make a sudden rush up to the angle of the building, and then dividing, there would be nothing left for them but to run the gauntlet as they best could to their separate points, either along the bottom of the little ditch dug to give height to the lower loopholes, or close along its edge. All this would be the business of a minute or two The bag for blowing in the window would either be propped up against it with a thick stick, or it might be laid on the sill. That for forcing out the timbers of the tambour might be hung upon a single nail, driven in at the time, or the loop would be thrown over the top of one of the timbers The men for watching the adjoining loopholes should stand as close as they could to them, not exactly in front, but a little on one side, and keep up a constant fire into them, avoiding exposure as much as possible, either from the loopholes on each side, or those which might flank the place where they stood. It would be a needless exposure of men, and the worst of two evils, to make a general attack on loopholes, unless under particular circumstances, where there was only one row, or that something had to be done which would require a party to remain exposed for a considerable time In cases where there were two or more rows of loopholes, and the defenders had the means of throwing grenades, or rolling shells down from the upper windows, besides giving their fire, the means of attack would not be commensurate with those of the defence, and it would not therefore be prudent to attempt it; but on a limited scale, and when it *must* be done, loopholes may be successfully disputed by superior numbers if you can get near enough to make pretty sure of firing in, the closer you are, too, the less you are also exposed to any direct fire from others See Plans to 'Defence of Posts'

When the bags were fixed, the fuzes would be lighted, and if the men could retire some 10 or 12 yards, close against the wall between any two loopholes, till the explosion took place, it would be safer than attempting to go back to the spot from whence they came. At this juncture,—the axemen,—the party with the ladders,—and one or both storming parties, should be perfectly prepared for springing forward The moment the explosion takes place they should be up and away The ladders would either be applied to the windows, as they would be in an escalade, or if the windows were low, they would be of service to form a kind of bridge for crossing the ditch, which might prove an obstacle to getting in A firing party would watch the opening and the adjacent loopholes, and the storming party would resolutely enter the moment the passage was ready, closely followed by the support, which would at the proper moment advance from its place of concealment

With respect to the Attack on the Tambour, some little delay might be necessary, as the storming party could not enter till the inner door was forced The axemen would therefore ply away till they had accomplished its destruction, during which time other men sent for the purpose might recreate in firing through the loopholes, to assist in clearing the passage When the door was forced, the storming party would

2ndly. The troops destined for this duty should be divided into two portions, *each* equal in strength to three fourths of the garrison attacked; one portion being the attacking party, and the other half the reserve or supporting party.

3rdly. Each column of the attacking party will also be subdivided into advance—main body—and support, whatever may be the number of these columns.

4thly. The disposition of the attacking party as it reaches the point attacked will be regulated by the Engineer Officer subject to the Officer commanding; the necessary reconnoissance having been made by them, and the party furnished with tools, ladders, and proper implements adapted to the circumstances of the moment, as well as being accompanied by a detachment of Sappers.

5thly. The disposition of the reserve, equal, as before observed, to the whole attacking force, should be regulated by the Officer intrusted with the execution of the Assault; and this reserve should be accompanied or not, according to circumstances, by Cavalry and Field Artillery. When these descriptions of force are present, the former should be placed under cover or out of gun shot, about 1500 yards; the latter should be kept in hand until the attacking party is engaged, when the guns should be spread out on the flanks, and open a vigorous fire upon the works;—the Infantry brought immediately in rear of the attacking portion under cover, if possible, from fire of grape and musketry, halted until the issue of the first assault is seen.

6thly. It is impossible to regulate an Assault by any minute suggestions for the advance, except to observe that it is usual for each column to attack the salient points of the works, and least defended portions of the place;—to throw out skirmishers and firing parties in front in any cover available, and to keep up a rapid and compact fire upon the defenders;—to follow with the Sappers and Grenadiers to force all obstructions, and then to advance the main body;—the supports of each body being judiciously planted in the rear.

Eventually, as success occurs, and the whole move on, points of security should be taken up, such as the reverse or the exterior slope of the works, buildings, walls, as well as gorges and flanks, which frequently give cover. Men should be planted under an Officer with instructions to take no notice of the pêle mêle, but to keep up a heavy firing in front, employing the Sappers in intrenching the position taken up by the supporting party, or in collecting waggons, carts, carriages, &c. &c., capable of being made into a barricade.

7thly. Either in the supposition that the success of the Assault is doubtful, or that there is a check or a repulse;—the reserve in the first case, to render success doubly sure, should move forward under the Officer commanding the whole force, and relieve the assailants, the original attacking party taking their place as reserve as soon as order can be restored;—the Artillery brought into position in the openings between the advancing columns, and directed upon the retreating or resisting forces; and if success is final and complete, the Cavalry, in event of their being employed, will also move forward, either through the openings cleared, or by a detour, if a fortified town, in pursuit.

In the second case, that of a check, the reserve, on the reconnoissance of the Officer commanding, will either move forward in support of the attack, or to cover the retreat, if further perseverance in assault is deemed impracticable; the Artillery and Cavalry being warned as to the intention.

In event of the Assault being repulsed, the reserve, which should be in echellon of corps, having advanced guards in front, will allow the retreating party to move through the intervals, and the advanced guard will endeavour to check the pursuit; if overpowered, they will fall back on the reserve, and the whole may in that manner retreat until beyond gun shot;—there endeavouring to make a stand, repulse the

garrison, and if possible convert failure into success, if the pursuit has been badly conducted, and without due caution.

The Artillery will retire as soon as it is certain that failure has occurred, and, by a new position, cover the retreat. The Cavalry will also retire, and check any advance of a similar force of the pursuing party.

Lastly. As an important rule in all Assaults, the composition of the forces should be by *regiments or corps*, and not by detachments: also, each Non Commissioned Officer should be provided with the means of spiking a gun, for which purpose even an old nail is sufficient.

The points here noticed are of importance in all Assaults, except in partial attacks, as on an outwork, or any particular work in which a *lodgement* is to be made; local circumstances then regulating the *time*, the number employed, and the *mode* of execution.

The necessity of a sufficient reserve, ready and at hand, in support of the assaulting party, each equal to three fourths of the garrison or force attacked—and of the immediate presence of the Officer commanding, in connection with the attacking force, is inferred from the *recollection of our want of success at Buenos Ayres, and at Bergen-op-Zoom*. By the arrangements suggested, an unsuccessful attack may be rendered less disastrous; and prevent checks and difficulties when on the point of gaining the object.

It frequently happens that troops led to the Assault obtain a partial success, and then are at a loss how to proceed: no responsible person being present to direct further operations, there is a pause,—the defending party rallies—attacks in its turn,—then comes a retrograde movement—confusion, and finally—*defeat*. Should, however, *the Reserve, together with the Responsible Head, be at hand*, these untoward events are not likely to occur; for as soon as success is apparent, the Reserve advances further orders are given, and *final* success is the probable result.

Indeed, Assaults, *if feasible*, would seldom fail with these precautions, and there are few Posts but what are open to assault, by taking the proper opportunity. And no Officer intrusted with the defence of a place should consider himself secure without unremitting vigilance, except in such cases as works surrounded by deep water, impassable marshes, or by walls or precipices at least 37 feet high, or where the approach is by a narrow causeway, easily watched. G. G. L.

B.

BAROMETER.—The only practical application of this instrument which is now offered is in the determination of heights above the sea level. The *memoranda* respecting Observation, Registry, &c., are taken from the 'Report of the Committee on Physics and Meteorology, of the Royal Society,' 1840. For the form of Registry, see 'Meteorology.'

The Tables computed by Mr Howlett, in vol. I. of the Corps Papers, are those which are selected for Barometrical measurements: they are accompanied by the formulæ of Isaac Dalby,* and Sir G. Shuckburgh, as means of approximate check where verification may be desired.

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* Commonly called General Roy's formula.

Mr Howlett's Tables —In using these, the column letters have been changed to obtain the advantage of significant Initials to a greater extent. Under these circumstances the rule given stands thus

$$\text{Log difference of feet in altitude} = \log R + X + Z$$

$$R \text{ being} = \log b - (X + \log B)$$

	Upper	Lower
Where Barometer is	B	b
Attached thermometer . . .	A	a
Detached thermometer . . .	D	d

Also:

$$\left.\begin{array}{l} \Delta = A \backsim a \\ S = D + d \\ L = \text{latitude} \end{array}\right\} \text{ and } \left\{\begin{array}{llll} X & \text{correspondent in Table to} & & \Delta \\ Y & \text{"} & \text{"} & S \\ Z & \text{"} & \text{"} & L \end{array}\right.$$

Dalby and Shuckburgh.

Dalby Difference of altitude in fathoms

$$= \left\{10000\,t \mp .468\,\Delta\right\} \times \left\{1 + (M - 32^\circ) \times .00245\right\}$$

Shuckburgh Do $= \left\{10000\,t \mp .44\,\Delta\right\} \times \left\{1 + (M - 32^\circ) \times .00243\right\}$

The sign $-$ is used where the attached thermometer is highest at the lower station
" $+$ " " lowest "

In the above, $\left.\begin{array}{l} t = \log b - \log B \\ M = \dfrac{D + d}{2} \end{array}\right\}$ the other quantities being as before

Example

In lat 51° 28′

	Barometer	Attached thermometer	Detached thermometer
Lower	29.862	68°	71°
Upper	26.137	63°	55°

1st To find R.

$$\begin{array}{lrr} \text{Log } b\ (29.862) & & = 1.4751189 \\ \text{Log } B\ (26.137) & = 1.4172557 & \\ 68^\circ - 63^\circ = 5^\circ, \text{ and } X \text{ to } 5^\circ & = 0.0002171 & \\ \hline X + \log B & = 1.4174728 & = 1.4174728 \\ \hline & & 0.0576461 = R \end{array}$$

$$\begin{array}{llr} \text{2ndly} & \text{Log } R\ (0.0576461) & = 8.7607315 \\ & Y\ (\text{to } D + d = 71^\circ + 55^\circ = 126^\circ) & = 4.8095776 \\ & Z \text{ to lat } 51^\circ\,28 & = 9.9997466 \\ \hline & \text{Log diff ft in altitude} & = 3.5700557 = 3715.8 \text{ feet} \\ \hline & \text{By Dalby's formula it is} & 3720 \text{ feet} \end{array}$$

which gives a difference of only 4.2 feet —a difference that is quite unimportant in ordinary operations if greater nicety be required the Barometer is hardly the instrument to be selected

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Thermometers to the Barometers.			Thermometers in the open air.								Latitude of the place.	
	X		S	Y	S	Y	S	Y	S	Y	L	Z
	Ther. highest at lowest	Ther. lowest at lowest										
											°	0 0011699
												0011624
												0011433
												0011117
												0010679
												0010124
												0009459
												0008689
												0007823
												0006874
												0005848
												0004758
												0003615

MEMORANDA FROM THE REPORT OF THE COMMITTEE ON PHYSICS AND METEOROLOGY, OF THE ROYAL SOCIETY, 1840.

Times of Observation.—The purposes of meteorological observations would be most perfectly and most expeditiously obtained by hourly observations throughout the year; but since in the case of private observers in general, and in few public esta-

subject, and to insure that uniformity of system at different stations ... value of such observations so much depends. It is probable that the hours of 3 A.M., 9 A.M., 3 P.M., and 9 P.M., nearly coincide with the daily maxima and minima of the barometric column at the level of the sea, over a large portion of the globe; and it is desirable that as extensive a comparison as possible should be instituted at these hours. At the Magnetic Observatories it is provided that observations shall be made every second or even hour of Gottingen mean time throughout the twenty-four; so that there at least, and in all others which will act in concert and correspondence with them, the complete diurnal cycle will be satisfactorily observed. It would be useless, and superadding labour to the already extensive task imposed on these establishments, to require observations also at the hours above recommended for general

adoption as *meteorological* hours They will, therefore, content themselves with filling up the forms furnished them, as adapted to the meteorological hours, with observations made at the nearest *magnetic* hours to those named at each station

It is not, however, too much to expect that hourly observations should be made, during 24 hours, once in every month, by those who profess to pursue meteorology in a scientific manner; and when this cannot be effected, it is of the utmost importance that they should be made at least four times in the year, namely, at the summer and winter solstices, and at the spring and autumn equinoxes One of the results of these hourly observations would probably be the indication of the exact times of the daily maxima and minima of pressure at different stations, which, if not found to coincide with the hours provisionally adopted, might ultimately be substituted for them under future directions. At the Magnetic Observatories the instruments will be read off hourly, on the days set apart in each month for the *magnetic term observations*, and the two hourly system of observation in all cases continuing uninterrupted, will in effect furnish corresponding observations on all other days, whether arbitrarily chosen to suit private convenience, or in pursuance of the system about to be proposed in the subsequent paragraphs

Hourly observations at the equinoxes and solstices have been already instituted at numerous points both of Europe and America, at the suggestion of Sir John Herschel, whose directions should be strictly attended to They are as follows

The days fixed upon for these observations are the 21st of March, the 21st of June, the 21st of September, and the 21st of December, being those, or immediately adjoining to those, of the equinoxes and solstices in which the solar influence is either stationary or in a state of most rapid variation *But should any one of those 21st days fall on Sunday, then it will be understood that the observations are to be deferred till the next day, the 22nd* The observation at each station should commence at 6 o'clock A M of the appointed days, and terminate at 6 A M of the days following, according to the usual reckoning of time at the place

The commencement of each hour should be chosen, and every such series of observations accompanied by a notice of the means used to obtain the time, and when practicable, by some observation of an astronomical nature by which the time can be ascertained within a minute or two

The Committee now propose to extend these observations in regular series to the 21st of every month, with the same reservation with regard to Sundays

Travellers provided with meteorological instruments, who may be stationary on any of these days, may use them with advantage on such opportunities Such as may ascend high mountains are recommended, *cæteris paribus*, to choose one of these days as affording a greater probability of securing a complete series of corresponding observations than any other, for which reason these observations cannot be too strongly recommended to *residents* in mountainous countries The geologist, nay, even the surveyor, may find his account in traversing his field, barometer in hand, on one of these days, provided he have reason to presume that there exist observers in its neighbourhood who take a part in these observations

It is to be hoped that to scientific meteorological observers the six hourly observations may not be found to be impracticable throughout the year, but in any case where it may be impossible to observe regularly at 3 A M, an effort should be made to include the hour on the days of the new and full moon, and quadratures, or at least on the days of the new and full moon,—as it must be borne in mind, that in what concerns the great meteorological questions on which the most important features of the subject depend, the night is quite as important as the day, and has been hitherto far too much neglected

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Thermometers to the Barometers			Thermometers in the open air								Latitude of the place	
	X		S	1	S	1	S	Y	S	1	L	Z
Δ	The highest at lowest station	The lowest at lowest station										
			40	[illegible]	75	[illegible]	110	[illegible]	145	[illegible]	0	[illegible]
			41	7691721	76	[illegible]	111	[illegible]	146	[illegible]	3	[illegible]
			42	[illegible]	77	[illegible]	112	8022109	147	8149339	6	·0011433
0	0·0000000	0·0000000	43	[illegible]	78	[illegible]	113	[illegible]	148	[illegible]	9	0011117
1	0000434	9·9999 63	44	[illegible]	79	[illegible]	114	8041861	149	[illegible]	12	[illegible]
2	[illegible]	·9999131	45	[illegible]	80	[illegible]	115	·8015430	150	[illegible]	15	·0010121
3	0001301	[illegible]	46	[illegible]	81	[illegible]	116	8050595	151	[illegible]	18	[illegible]
4	[illegible]	[illegible]	47	[illegible]	82	[illegible]	117	[illegible]	152	8211501	21	[illegible]
5	0002171	[illegible]	48	[illegible]	83	[illegible]	118	[illegible]	153	8215944	24	[illegible]
6	[illegible]	[illegible]	49	[illegible]	84	[illegible]	119	8065054	154	[illegible]	27	[illegible]
7	·0003039	[illegible]	50	[illegible]	85	[illegible]	120	[illegible]	155	[illegible]	30	0005819
8	[illegible]	[illegible]	51	[illegible]	86	[illegible]	121	[illegible]	156	[illegible]	33	[illegible]
9	[illegible]	[illegible]	52	7714151	87	7915012	122	[illegible]	157	8232317	36	·0003613
10	·0004341	9·9995 655	53	[illegible]	88	[illegible]	123	[illegible]	158	[illegible]	39	[illegible]
11	[illegible]	[illegible]	54	[illegible]	89	[illegible]	124	[illegible]	159	[illegible]	42	·0001225
12	[illegible]	[illegible]	55	[illegible]	90	[illegible]	125	[illegible]	160	[illegible]	45	·0000000
13	[illegible]	[illegible]	56	[illegible]	91	[illegible]	126	[illegible]	161	[illegible]	48	[illegible]
14	[illegible]	[illegible]	57	[illegible]	92	[illegible]	127	[illegible]	162	[illegible]	49	[illegible]
15	[illegible]	[illegible]	58	[illegible]	93	[illegible]	128	[illegible]	163	[illegible]	50	[illegible]
16	[illegible]	[illegible]	59	[illegible]	94	[illegible]	129	[illegible]	164	[illegible]	51	[illegible]
17	[illegible]	[illegible]	60	[illegible]	95	7953591	130	[illegible]	165	[illegible]	52	[illegible]
18	[illegible]	9·9921 6	61	7791019	96	[illegible]	131	[illegible]	166	[illegible]	53	[illegible]
19	[illegible]	[illegible]	62	[illegible]	97	[illegible]	132	[illegible]	167	[illegible]	54	[illegible]
20	[illegible]	[illegible]	63	7801677	98	[illegible]	133	[illegible]	168	[illegible]	55	[illegible]
21	[illegible]	[illegible]	64	7806130	99	[illegible]	134	8131749	169	[illegible]	56	[illegible]
22	[illegible]	[illegible]	65	[illegible]	100	[illegible]	135	[illegible]	170	8290003	57	[illegible]
23	[illegible]	[illegible]	66	7816090	101	7991421	136	8140649	171	[illegible]	58	[illegible]
24	[illegible]	[illegible]	67	[illegible]	102	[illegible]	137	8143133	172	[illegible]	59	[illegible]
25	0010463	[illegible]	68	[illegible]	103	[illegible]	138	[illegible]	173	[illegible]	60	[illegible]
26	0011377	[illegible]	69	[illegible]	104	[illegible]	139	[illegible]	174	[illegible]	63	[illegible]
27	0011710	[illegible]	70	[illegible]	105	[illegible]	140	[illegible]	175	8311336	66	[illegible]
28	0012143	[illegible]	71	[illegible]	106	8001333	141	[illegible]	176	8315930	69	[illegible]
29	[illegible]	[illegible]	72	[illegible]	107	[illegible]	142	816 113	177	[illegible]	72	[illegible]
30	·0013009	[illegible]	73	[illegible]	108	[illegible]	143	[illegible]	178	[illegible]	81	[illegible]
31	0013443	[illegible]	74	7851458	109	8010343	144	[illegible]	179	[illegible]		

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	X		t	λ	q	Y	q	Y	q	Y	L	Z
δ	Ther highest at highest station	Ther lowest at lowest station										
			40	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			
			41									
			42									
0	[illegible]	[illegible]	43									
1	[illegible]	[illegible]	44									
2	[illegible]	[illegible]	45									
3	[illegible]	[illegible]	46									
4	[illegible]	[illegible]	47									
5	[illegible]	[illegible]	48									
6	[illegible]	[illegible]	49									
7	[illegible]	[illegible]	50									
8	[illegible]	[illegible]	51									
9	[illegible]	[illegible]	52									
10	[illegible]	[illegible]	53									
11	[illegible]	[illegible]	54									
12	[illegible]	[illegible]	55									
13	[illegible]	[illegible]	56									
14	[illegible]	[illegible]	57									
15	[illegible]	[illegible]	58									
16	[illegible]	[illegible]	59									
17	[illegible]	[illegible]	60									
18	[illegible]	[illegible]	61									
19	[illegible]	[illegible]	62									
20	[illegible]	[illegible]	63									
21	[illegible]	[illegible]	64									
22	[illegible]	[illegible]	65									
23	[illegible]	[illegible]	66									
24	[illegible]	[illegible]	67									
25	[illegible]	[illegible]	68									
26	[illegible]	[illegible]	69									
27	[illegible]	[illegible]	70									
28	[illegible]	[illegible]	71									
29	[illegible]	[illegible]	72									
30	[illegible]	[illegible]	73									
31	[illegible]	[illegible]	74									

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Whatever hours, however, may be selected for the regular series of observations, the greatest care should be taken not to insert in the register anything deduced by interpolation from observations made at other hours, or anything, in short, but what has been actually observed.

It is much to be wished that occasional observations may be made under remarkable circumstances, such as during great rises or great falls of the barometer, at the period of great storms, earthquakes, &c; but such observations should be registered apart.

The barometer should be placed in an apartment subject to as little variation of temperature as possible, and in a good light, and to facilitate night observations, an arrangement should be made for placing behind it a light screened by a sheet of white paper, or other diaphanous substance. Great care should be taken to fix it in a perpendicular position by the plumb line. Its height must be carefully ascertained above some permanent and easily recoverable mark, either in the building in which it is situated, or in some more permanent building, or rock in its immediate vicinity, and no pains should be spared to ascertain the relation which such mark may bear to the level of high and of low water at spring tides, and ultimately to the mean level of the sea.

Changes in the adjustments of meteorological instruments should be most carefully avoided; but whenever any alterations may be absolutely necessary, they should be made with all deliberation, scrupulously noticed in the register, and the exact amount of the change thence arising in the reading of the instrument under re-adjustment ascertained. As far as possible, registers of meteorological observations should be complete, but if, by unavoidable circumstances of absence, or from other causes, blanks occur, no attempts to fill them up by general recollection, or by the apparent course of the numbers before and after, should ever be made.

The Observatories established by the Government are furnished with two barometers each, of Newman's construction—the one a standard, and the other portable, and they are accompanied by accurate directions for fixing and observing them.

The standard instrument is of large dimensions, its tube being of the diameter of 0.6 inch. It requires two adjustments. 1st. The whole scale, which is of brass, is moveable, and terminates in an ivory point, which is carefully brought down to the surface of the mercury in the cistern, and the two are known to be accurately in contact when the actual point and its reflection appear just to touch one another. The scale is laid off from this point from an authentic standard, at the temperature of 32°.

2nd. The second adjustment is that of the vernier, in which the upper part of the scale terminates, to the surface of the mercury in the tube. For this, both the back and front edge are made to coincide, and brought down so as to form a tangent to the curve, and just to exclude the light between them at the point of contact. In making both these adjustments it is desirable that the eye should be assisted by a magnifying glass. Before the observation is made, the instrument should be slightly tapped to free the mercury from any adhesion to the glass, but any violent oscillation should be avoided.

The Portable Barometer has only one adjustment, namely, that of the vernier to the upper surface of the mercury in the tube, which adjustment must be effected with the same precaution as in the case of the standard instrument.

This first reading may be entered in the column prepared for it in the register, and beside it the temperature of the mercury carefully read off from the thermometer which dips into the cistern.

As in the case of the Standard Barometer the first measure is taken immediately

from the surface of the mercury in the cistern, it requires no correction for the different capacities of the tube and cistern Neither does it require any correction for capillary action, as the large diameter of the tube renders this correction inappreciable

The Portable Barometer, however, requires corrections for both these circumstances For the purpose of the former, the *neutral point* is marked upon each instrument, or that particular height which, in the construction of the instrument, has been actually measured from the surface of the mercury in the cistern

It is obvious that in almost every case the mercury will stand either above or below the neutral point if above, a portion of the mercury must have left the cistern to enter the tube, and consequently must have lowered the surface in the cistern if below, a quantity of mercury must have left the tube, and, entering the cistern, raised the level of the mercury in it For the correction of observations for this circumstance, the relation of the capacities of the tube and cistern have been experimentally ascertained and are marked upon the instrument thus *capacity* $\frac{1}{50}$th indicates that for every inch of elevation of the mercury in the tube, that in the cistern will be depressed one 50th of an inch Thus, when the mercury in the tube is above the neutral point, the difference between it and the neutral point is to be divided by the capacity, and the quotient being added to the observed height, the result will be the corrected height. Or if the mercury at the time of observation should be below the neutral point, the difference of the two is to be divided as before, and the quotient to be subtracted from the observed height. Thus, suppose the capacity to be $\frac{1}{50}$th, the neutral point 30 inches, and the observed height 30 500 inches, the difference is 0 5 inch, which divided by 50, gives 0 01 inch to be added to the observed height, producing 30 51, the corrected height, or if the observed height be 29 inches, the difference 1 inch, divided by 50, gives 02 inch to be subtracted from the observed height, giving 28 980 inches for the corrected height

The second correction required is for the capillary action of the tube, the effect of which is constantly to depress the mercury in the tube by a certain quantity inversely proportioned to the diameter of the tube In the instruments furnished to the fixed Observatories the amount has been experimentally determined during their construction, and marked upon the instrument, the quantity is always to be added to the height of the mercurial column, previously corrected as before For the convenience of those who may have barometers, the capillary action of which has not been so determined, a Table of the corrections for tubes of different diameters is given

The Marine Barometers differ in nothing from the other Portable Barometers but in the mode of their suspension and the necessary contraction of the tubes to prevent oscillation from the motion of the ship, and require the same corrections

When these two corrections have been made in the first reading of the Portable Barometer, it should agree with the direct observation of the Standard Barometer, and it is very desirable that frequent comparative observations should be made of the two instruments, in order to ascertain whether there may be any permanent difference between them Should this be the case, the amount may be marked upon the instrument, and allowed for as an index error, in order that, if an accident should happen to one, the other may be substituted for it without detriment to the regular series of observations

It is to be presumed that the Portable Barometer will frequently be employed in ascertaining the altitude of remarkable points in the vicinity of the Observatory

The instruments furnished to the Observatories have been all independently graduated and compared with the standard of the Royal Society, and in all cases it

TABLE III

Correction to be applied to Barometers, the scales of which are engraven on glass, to reduce the observations to 32° Fahrenheit

Temp	Inches 28·0	Inches 28·5	Inches 29·0	Inches 29·5	Inches 30·0	Inches 30·5	Inches 31·0	Inches 31·5
25	+ ·017	+ ·017	+ ·017	+ ·018	+ ·019	+ ·018	+ ·019	+ ·019
30	+ ·003	+ ·003	+ ·003	+ ·003	+ ·003	+ ·005	+ ·005	+ ·005
35	− ·007	− ·007	− ·007	− ·008	− ·008	− ·009	− ·008	− ·008
40	− ·019	− ·020	− ·020	− ·020	− ·021	− ·021	− ·021	− ·022
45	− ·031	− ·032	− ·032	− ·033	− ·033	− ·034	− ·035	− ·036
50	− ·043	− ·044	− ·044	− ·046	− ·046	− ·047	− ·048	− ·049
55	− ·055	− ·056	− ·057	− ·058	− ·059	− ·060	− ·061	− ·061
60	− ·067	− ·069	− ·069	− ·071	− ·073	− ·074	− ·075	− ·076
65	− ·079	− ·081	− ·082	− ·083	− ·085	− ·086	− ·088	− ·089
70	− ·091	− ·093	− ·094	− ·096	− ·099	− ·100	− ·101	− ·103
75	− ·103	− ·105	− ·106	− ·109	− ·111	− ·114	− ·116	− ·119

R J N

BARREL.—See 'BRIDGE, CASK'

BARRICADE—considered as a *temporary* obstruction to attack,—from the occupation of buildings converted into strong defensible posts, in the field —to the hasty arrangements against insurrectionary movements in towns

Reserving the former for its more appropriate heading, 'Defence of Posts,' reference will now only be made to the latter, and in the original sense of 'Barricade,' as derived from 'Barrique,' in allusion to the defences of the streets of Paris during the disturbances of the League, &c

The character of the expected attack will determine the most general arrangement for the barricade If from the town, or country, only, the line of defence will be single, if from both, the points to be defended must be considered accordingly, not so much by double lines, as by being ready, front and rear, at those points

In barricading a town, in whole, or part, it should be considered as *a position*, and every attention paid to the control of communications, to the stock of ammunition and provisions, and to the reduction of the space to be enclosed to the smallest advisable limits, so as to economize time, materials and forces necessary for the more passive sort of defence, leaving as many as may be for that of an active character

In all cases, the general maxim for field defences, of never leaving obstacles unsupported, must be borne in mind; especially, as in streets, where it may not be always possible to man the barriers, owing to the fire of the neighbouring houses, and when they can only be held by occupying the contiguous and flanking dwellings.

BARRICADING IN TOWNS

The Barricade may consist of moveable portions of palisading, (figs. 1, 2) made musket proof by sand bags In some recent arrangements for defence, in Ireland, the following was the detail

Per 5 ft width of Street

1 Bay of palisading, 5 ft. wide.
70 Bushel sand bags, filled.
1 Mallet, hand.
1 Block, wood, 12" × 6" × 3" } to rectify any uneven-
1 Wedge, do 12" × 3" } ness in the streets
1 Hand hatchet.
1 Sapper, 4 of the Line
1 large cart, to contain the above materials

Per Barrier.

1 Crow bar
1 Sledge hammer.
1 Felling axe
1 Pioneer.

Figs 6 and 7 shew the mode in which these bays should be arranged.

Chevaux-de-frize were required, as at *a*, fig 6, for barriers to those streets where thoroughfare was to be permitted, or in front of the parapets of sand-bags, with which blind alleys, or other suspicious openings, were to be closed

In fig 7, a recess of about 10 ft is allowed, not to interfere with passengers, or be interrupted by them.

The above cannot in general be managed without some warning, as the equipment requires an amount of labour, material, and transport, not easily commanded, since each 5-ft bay of palisading weighs about 450 lbs, and measures upwards of 20 cubic feet in transport The following series of Barricade afford means of closing openings in various ways, *most of them practicable under all circumstances.*

1 Palisading, moveable, as above, or fixed, as usual.

2 Stockade* of trees, from esplanades, avenues, canals, gardens, &c } loopholed, the bottom of the loophole not less than 8 feet above the ground outside

3 Stockade of squared baulk, from the timber-yards } loopholed, the bottom of the loophole not less than 8 feet above the ground outside

4 Abattis; with, or without, parapet of earth and ditch, behind

5 Parapet of baulk, or of logs roughly trimmed,—provided they reach across the road, and either enter the walls, or can be well secured to them

6. Barrels, hampers, or sacks filled with earth, as a parapet, a ditch in front, avoiding parapets of paving stones as much as possible

7. Earthen parapets, with plank revetments, supported by posts

8 Carts, waggons, &c, jammed and lashed together

9 Iron railing, removed bodily in convenient lengths, from enclosure walls, areas, &c.

10 Chevaux-de frize: this, only occasionally, for particular points, especially for closing passages in the main Barricades, as a sort of temporary gate

11. Sand bag parapets,—with chevaux de frize in front, and loopholed above this also is only an occasional resource

&c., &c., &c.

Open iron gates are best rendered proof by oaken mantlets See figs 3, 4, 5

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* See 'Stockade'

The following are the thicknesses of ordinary materials, as determined by recent experiments,—

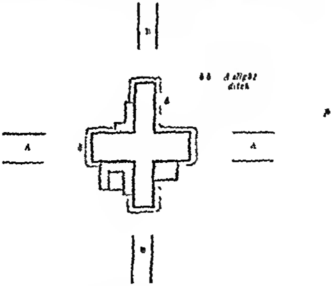
Walls, Brick, 1 brick thick,
Granite, Compact Limestone, Ditto Sandstone } 6 inches, solid stone,
Cob (clay and straw) 9 inches thick,
Width of 1-bushel sand-bag, at least 10 inches, full of earth,
*12 inches thick,—White pine,
* 9 do Yellow do.
* 4 do. Oak, good
2 do. Oak, sheeted with ¼-inch wrought iron,†
⅜ do. Sheet iron,

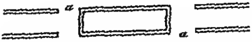
are the lowest that should be relied on as musket-proof.

BARRICADING ON THE OUTSKIRTS OF TOWNS.

As Insurgents are seldom burthened by artillery or baggage, they are not compelled to keep to the roads, where they would be most exposed; they will be apt to disperse over the fields, hence all hedges, or walls, parallel to the front of attack, or anything else that may give cover, should be removed

Where two tolerably wide roads, AA, BB, cross, they can generally be cut off so as to form a very fairly flanked redoubt, forbidding all advance along the roads themselves, the houses serving as barracks, and often capable of being loopholed.





If no crossings present themselves, any block of wide road, with an ordinary hedge,

* These thicknesses are best made up of different courses of plank crossing alternately, as in fig

has only to be closed at the end or ends, by moving up the portions *a*, *a*, and a respectable 'Barrier' may still be obtained. This and the preceding are particularly suitable to the case where provision has to be made to front and rear.

Nearly all the expedients given for Barricades in the towns are more or less applicable to suburbs, and the immediately adjacent outskirts, but it is highly unadvisable, in most instances, to lose sight of the principle of concentration by this extended occupation. In addition to this list of expedients for towns in the country, or in villages, &c., we have field gates, and often hurdles, both excellent in forming revetments and earthen parapets. R. J. N.

BARRIER—as distinct from 'Barricade' and considered only in relation to Fortification.

The purpose regulates the construction. If the barrier is to be permanently defensible, it should be musket proof, and then becomes a stockade.—See 'Stockade.'

If occasionally defensible, or else simply obstructive, palisading will suffice, with a sand bag or other temporary parapet when required, behind and near enough to fire between the palisades.—See 'Palisade.'

The gates in both the above should if possible be of palisading, as the heavy stockade gate is unwieldly. If its being musket proof is indispensable, 2 inch oak plank, covered with ½ inch sheet iron, will be lighter and more effective,—*if* such materials can be procured.

Here the subject cannot be pursued farther without intrenching on 'Gate,' but as the higher class of field works require such provision, the construction of a barrier gate is given in the Plate.

To regulate the width of the opening, 10 feet effective is assumed for waggons, carts, &c., of any size, as sufficient for a two leaved gate. The one leaved gate is given at 4 feet, as enough for a single horseman or infantry two deep. A slight change must be made in fig. 1 if it is to be framed to admit of a wicket.

In the diagrams given, especially figs. 1, 2, the framing and scantling have been so regulated as to give abundant stability and strength to the whole, particularly the main posts *a*, without shewing the struts *c*, *d*, *f*, above ground, where they are not only in the way, but more likely to decay, especially where they enter the earth. If the level of the sleeper, *b*, admits of drainage, the whole should be laid and rammed tight with dry rubble, to allow the water to run freely off.

The gates themselves are so hung as to fall back clear of the opening; the hinges are kept entirely to the rear, and the upper ones are inverted. The heel posts and meeting-stiles are allowed a sufficient thickness for the rails to enter without reduction at tenons; these rails are guarded by a strap of iron 2" × ½" along the upper edge, to prevent their being readily cut through with an axe. The palisades are 6" × 6" scantling cut arris wise, and 4" apart; if much more, it would be possible for a thin person to work through.

The bar *g* is given as merely an ordinary security. If more be required, a strong chain and padlock between two stout staples of ½ inch iron will answer all purposes conveniently.

Barrier gates should never be left unprotected.

When there is not time to construct such gates as are given in the Plate, the

following figure gives a tolerable substitute, and one that can be readily put together.

R. J. N.

BATTERY.—This article has been compiled partly from Notes by Lieut. General Sir John Burgoyne, from some of the best authorities, and from reminiscences of the Compiler when in the Field.

Preliminary Remarks.—A Battery consists of two or more pieces of artillery united for the purpose of dispersing troops, or destroying that which covers and protects them. The term Battery also implies the emplacement * of artillery destined to act offensively or defensively. In the modern use of the word it likewise means the equipment of a certain number of pieces of ordnance, which has been previously explained in the article 'Artillery.' A battery may be open or covered.

A Covered Battery may be with or without embrasures; in the latter (en barbette) the height of the genouillère varies according to the description of gun carriage used.

	ft	in
For Field or Travelling Carriages it should be .	3	0
Garrison Carriages	2	3
Ship do.	1	6

or for Guns on Traversing Platforms, to fire over a parapet, 6 or 7 feet high.

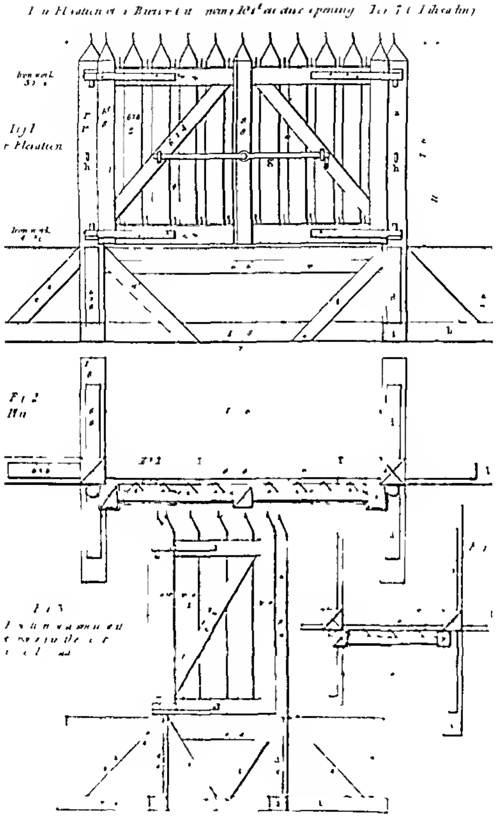
Batteries, when with embrasures, have these openings cut or built in the parapet not less than 18 feet from centre to centre, except in Breaching Batteries; the mass between the embrasures forming a trapezium is called the Merlon. The thickness of the parapet towards the enemy depends upon the nature of the battery, as is explained in Section VIII., and in the article on the 'Penetration of Shot.'

The artillery (which constitutes the battery—the parapets being merely the cover or protection from shot) requires substantial bearings either of solid ground for field pieces, or of timber, plank, or masonry platforms, for heavy artillery.

Batteries are divided into Siege and Field Batteries, as well as for the defence of coasts and that of places; the two last will be treated of in the article 'Defence.'

In the British Service, the construction of Batteries is an Engineer operation; this arrangement, different from that of most countries, probably arose from the nature of duties peculiar to our mode of warfare, generally confined to maritime expeditions and irregular attacks, where the construction of batteries and communications, and perhaps a parallel connecting them, constituted the principal works to be executed, and as the disembarkation of the ordnance, the park, laboratory duties, and placing the artillery in battery and working it, was sufficient to occupy that force, when celerity and the effect of a powerful fire was of the first importance. This arrangement it has been found convenient to continue, and the employment of Engineers and Sappers in the construction of Batteries permits an uninterrupted series of

* The emplacement of a Battery depends upon its object, whether for a momentary purpose in attack, or for the defence of a position, &c.



operations, which the French Engineer Officers are inclined to think the best — See Lieut General Sir Charles Pasley's 'Practical Operations of a Siege,' Article 221 Second edition

SIEGE BATTERIES

SECTION I.

DEFINITION

These Batteries are either for guns, howitzers, or mortars, and have two objects, when employed in reducing a place

First,—that of destroying the fire of the fort or fortress, as well as of ruining the parapets and military buildings, in order to approach, with as little risk as possible, to the place attacked, and,

Secondly,—when sufficiently near it, to effect a breach

SECTION II.

BATTERIES FOR THE FIRST OBJECT, OR DESTRUCTION OF DEFENCES

The early Batteries constructed in the First or Second Parallels, or from 30 to 50 yards from them, but sufficiently near to be protected by those parallels, are designated as Enfilade Batteries, Batteries in Reverse, en Écharpe, and Direct Batteries

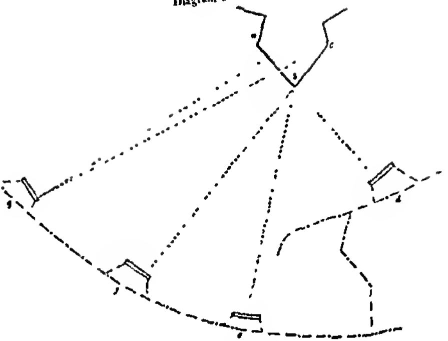
Those for Enfilade and Ricochet are established upon the prolongation of the face of a work, and perpendicular to that prolongation if that position cannot be taken, from the unfavourable nature of localities, such as rivers, morasses, &c, — then, by placing the Battery out of the prolongation, taking the interior of the face to be enfiladed obliquely, this will be a Reverse Battery when the same circumstances occur on the other or exterior side this will be a Battery en Écharpe lastly, when the Battery is opposite and parallel to the face it should destroy, it is then termed a Direct Battery The first of these four positions is the best as its raking fire does much to clear the whole length of the line of its defenders and defences the second has the same advantage, though to a modified extent

The third and fourth are the least advisable, because it takes a considerably longer time to effect the object—the ruin of the parapets Theoretically, the ricochet fire is the most efficacious, although in practice a difficult and nice operation, and only perfectly successful when long faces are open to enfilade

The diagram subjoined will explain the position of the different Batteries which may be required to ruin the defences of a fortified place *a b, c*, representing the bastion attacked *f* will be the Enfilade Battery, *g* that of the Reverse Battery, which subjects one face and flank of the bastion to reverse fire and the adjoining curtain to enfilade fire, but the position of this battery is a dangerous one, being liable to be overlapped and easily destroyed by Sorties, by its contiguity to the place, it should only therefore be placed when a river or marsh intervenes

The Battery en Écharpe may be necessary by the peculiarity of the ground, which prevents the parallel being extended as far as *f*, and the front of attack not reaching even as far as *e*, may render the Battery *d*, for direct fire, only available for the destruction of the defences of the bastion

Diagram 1



SECTION III.

BREACHING BATTERIES.

The position of Batteries to effect a *practicable* breach is contingent on the cover given to the Body of the Place attacked.

In sieges on paper they are generally placed on the crest of the glacis, but it may be at 50 or 500 yards, just as the walls are exposed; the emplacement of the near or distant Battery being a question of time and expediency: ten guns at the shorter distance will probably effect a breach, 100 feet wide, in 17 hours; and the greater in 74 hours: see article 'Breach.' But it may so occur that the escarp *may* be seen from a distant Battery, when it cannot from any intermediate point, except at the crest of the glacis; for instance, the guns of the Battery *f*, in the preceding diagram, may be able to breach the face *a*, *b*, of the bastion, by being on rising ground which slopes to the foot of the glacis: as regards time, therefore, it will be in favour of the distant Breaching Battery, the ulterior operations being confined to Sapping and Mining.

For the principles which generally regulate the *Emplacement* of Batteries, see article 'Attack,' by Lieut.-General Sir J. Burgoyne.

SECTION IV.

CONSTRUCTION OF BATTERIES FOR RUINING THE DEFENCES.

The construction of these may be as *Cavalier Batteries*, where the terreplein is raised above the level of the natural ground; *Sunken Batteries*, where the sole of the embrasure *is* on the general level of the ground; and *Half-sunken Batteries*, when the platform is about half *the* height of the genouillère below the level of the ground. These *batteries* are exceptions to the general rule of constructing them, and cannot be provided for by Tables, *or* suggestions for their execution, without complicated

statements of details, depending entirely upon local circumstances and the nature of the soil which is well explained in Section XII, from Sir J Burgoyne's Notes Sometimes it is necessary to elevate a Battery to preserve it from an inundation or to see an object which the artillery on the natural soil could not touch; and the ground sometimes requires a Sunken Battery to be constructed on the side of the hill sloping towards the place attacked

The Batteries common at sieges, whether for guns, howitzers, or mortars, are *Elevated* and Half sunken Batteries; the latter constructed, if possible, on the crest of rising ground, the slope falling from the place as explained in the diagram below: this position is most favourable as the part to be revetted need not be below the excavation of the platform, and the position is very secure, particularly against shells lodging in the rear.

Diagram 2 of a Half sunken Battery of 1 ft 6 in depth

The Elevated Batteries, executed on the level of the natural soil, are simple in their construction, the Half sunken being a modification of the Elevated, (see Plate I figs 1, 2) which it is easy to provide for at the moment, by making the necessary deductions, according to the figure of the ground where the Half sunken Battery may be placed.

SECTION V

TRACE OF THE ELEVATED BATTERY FOR GUNS OR HOWITZERS ON THE NATURAL LEVEL OF THE SOIL.

The tracing of this Battery for the destruction of the defences, whether for ricochet or direct fire, is usually executed by the Senior Officer of Engineers of the Brigade to be employed. After the Director of the Trenches has decided in conjunction with him the exact position of the battery, he should lay out the line of fire during the day, and when dusk, trace out the Battery in the following manner, taking care to be provided with a

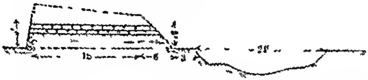
- Hambro' line,
- A square, or mason's level,
- Two dozen pickets, 18 inches long
- Two long pickets, per piece, of 4 or 5 feet, to mark the embrasure,
- A mallet,
- Crow-bar to penetrate very hard ground.
- And a 50 foot tape

Each and all of these articles are necessary, and without them, difficulties will occur when it is dark.

Thus provided, the Engineer Officer will trace the foot of the parapet perpendicular to the line of fire previously laid, fixing one end of the Hambro line upon a picket driven firmly in the ground at one extremity of the base of the interior slope of the parapet at the point marked 1, in diagram No 3, and then stretched to the other extremity marked 2, thence to the end of the epaulement or shoulder, 3, from this, to the berm at 4, 5, 6, and 7, shewing the interior line of the ditch of the battery to be excavated, from 7 across to 8 (the width of the ditch at the shoulder), and again

Distribution of the Relief or Second Party for the Construction of the Battery — Near the expiration of eight hours (the usual period given for a working party in the trenches), the relief, of the same strength as the first, will be brought down by an Engineer of the Brigade, who will have been sent to meet them, and conduct them to the spot. By this period the battery should be completed to the height of the genouillere, and part of the merlons to the height of 5 feet, as shewn in diagram No 5, unless unusual difficulties have been encountered from the nature of the soil, and from the heavy fire of the place

Diagram 5 —Shewing the state of the Battery at the termination of the work of the 1st party.



The arrangement of this relief will be as before, until daylight, when they should be changed, and the men removed from the parapet altogether, to prevent unnecessary casualties, as little is now gained by hastening the work, since the guns cannot open until daylight of the second morning, or in anticipating events in a regular siege, such as bringing in the guns and opening a partial fire, when the stores and ammunition are not collected in sufficient quantities

It is therefore proposed, in cases where the artillery will not be required to open fire until the second morning, that the earth thrown on the berm and superior slope should be left there in a heap until next night, which will mask the battery and allow the interior to be continued without difficulty, as explained in diagram 6

Diagram 6 —Shewing the state of the Battery at the termination of the work of the 2nd party.

Adverting to the change of the party, and the removal of the 42 men from the parapet and berm, they should at daylight be placed in improving the communications to the rear or parallel, as may be, and to the ditch of the battery; and the revetters may now reset the profile of the shoulders at the same time

The communication or road from the battery to the rear or parallel is presumed to have been commenced at the same time as the battery, and Table No II. provides for the men and tools for every 5 feet, the length of the tracing fascines; this removal from the parapet of 42 men is only to improve, give the necessary width and render the arming of the battery easy and convenient

The third party, which will arrive about 10 A M of the first morning, should bring down any remaining platforms and materials for the magazine, the execution of which is explained in Section IX, and the number of men and quantity of tools and materials given in Tables IV. to VIII, taking care, in laying the platforms that the

sleepers have good firm bearings, with a slope of ½ an inch to the foot, and (transversely) laid on a perfectly dead level

The last Engineer operation for the completion of the Battery will require a relief of about 72 men, to cut through the screen, which masked the work, for the embrasures, revetting them, and filling in the merlons this should be commenced at dark of the second evening

SECTION VII

BREACHING AND COUNTER BATTERIES

The construction of a Breaching Battery may either be effected as already explained in Section IV, and similar to all other batteries executed at a distance from the place attacked, when forming one of the early works of the siege,—

Or, by converting a lodgement into a Breaching Battery

The first description being already disposed of,—

The conversion of the lodgement only has now to be explained This operation is of two different kinds *One* may be performed on the reduction of an outwork, from whence the escarp of the place can be breached—the lodgement converted into a battery,—and the earth taken from the inside, instead of the ditch, as is usual in other batteries

The *second*, the conversion of the crowning of the glacis into a Breaching or a Counter Battery by Sap

First—The execution of a Breaching Battery, when a lodgement is secured in an outwork, is not difficult, although dangerous, inasmuch as the fire of the place can hardly be expected to be entirely overcome The first operation will be giving a full thickness of 18 feet to the parapet, and revetting the interior slope, the revetting, for expedition, may have the lower part made of gabions or casks which will serve to the height of the genouillere, and leave the merlons to be revetted after dark with fascines or sand bags, when the embrasures are cut The next work will be the widening the space for the platforms, and making the communication to the rear, as the earth must be taken from a considerable breadth little depth having been previously obtained. Sand bags and ballast baskets will come into requisition for clearing, filling the gabions and giving sufficient bulk for the parapet of the battery

This description of Breaching Battery will probably be commenced the morning after the lodgement is effected in the work (having reference more possibly to when the guns are required to open their fire), and as it will be done by daylight, the minimum number of men should be employed.—See Table III

At mid day the Battery, if commenced early in the morning should be ready for laying the platforms, and for the construction of the magazine, it would be so if *given as a task* to the men

The party for laying the platforms and magazine will be regulated by Tables IV to VIII., and the work executed according to Sections VIII IX, and before dark would be ready for the artillery *

The last operation—of opening the embrasures and revetting the merlons—may be performed at some convenient opportunity during the night when the battery is clear from other workmen, and the artillery of the place has perhaps slackened its fire When the openings of the embrasures are cut, a sap roller should be rolled into the extreme opening A few of the most skilful revetters should be employed, and fascines used in preference, as they stand longer, and would last, if well done, until the place is reduced. The merlons could be revetted with fascines, and filled in properly in 3 or 4 hours, if not under a very heavy fire.

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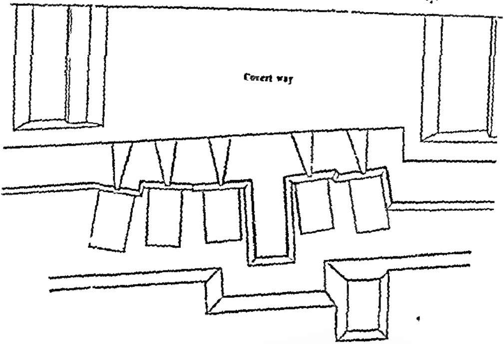
* The slope of the platform may be increased to one inch to a foot, and when travelling carriages are used the part for the trail still more See figs 5 and 8 Plate III.—G G L.

Diagram 14.—Breaching Battery in the *Crowning of the Covert-way.*



It is conceived that *this novel mode of constructing Breaching Batteries on the crest of the glacis will be found to be as successful as practicable.* In *any other mode of forming the embrasure, the opening of each must be cleared 4 feet at the interior, and 11 feet at the exterior.* Several men must be employed to execute that work *and revet it afterwards*, whilst in the method here proposed, *only two are necessary, and they only partially exposed*

Before daylight, a Miner to each embrasure will be required *to clear the remaining* part unopened, and cut away a portion of the brickwork or masonry of the retaining wall of the crest of the covert-way, which, with a crow-bar, may be done in a few minutes.

When the work is completed, and the artillery run in, the embrasures should be furnished with mantlets, hung on the interior opening, to protect the artillerymen from musketry fire, they may be made of three 3-inch deals, or two 2 inch oak planks, spiked together as shewn in Plate II fig 6

CONCLUDING REMARKS.

The following remarks upon Siege Batteries, arising out of some differences of opinion on minor points in the Construction and Position, &c, are offered by the Compiler

First, he is inclined to believe that all working parties, after the completion of the first parallel, should have their arms; for this reason—if a Sortie, or the alarm of a Sortie, occurs, the workmen have no rallying point, and they, or the most of them, return to their camp; whilst if their arms are piled, or laid securely, not far in the rear, they will invariably stand to them, and receive orders how to act.

Secondly, respecting revetting materials, it appears that the relative advantages of fascines, gabions, casks, or sand bags, consist more in their application than in the peculiar merit of one or the other; and each may be employed usefully in revetting batteries

Lastly the subject of Siege Batteries resolves itself into but two descriptions as regards the construction or labour,—those in which the parapets are taken from the ditch, and those formed from earth taken from the interior or terreplein of the battery. Any deviations are only modifications of these two.

There is one description of battery not adverted to but which is one of the second class, i.e. the Siege Battery en crémaillère; this is constructed under peculiar circumstances by the conversion of an embankment of a canal or dyke, on the bank of the opposite side of a river into a Siege Battery, and the materials taken from the inside.

C. G. L.

SECTION VIII

REVETTING SIEGE BATTERIES FROM NOTES* BY LIEUT GENERAL SIR J. F. BURGOYNE, G.C.B., R.E.

Batteries may be revetted with sand bags, gabions, or fascines.

SAND BAGS

The sand bag is a very favourite material for Batteries in our Service, but it does not last; such batteries not only require constant repairs all day, but the embrasures† must be rebuilt every night, to the great expenditure of sand bags and labour of Engineers and men. When, from want of time or other causes, ground is to be broken immediately on the investment and the batteries are to be commenced on the first or second night with a small besieging force, it is probable that Sand bag Batteries *must* be employed with all their disadvantages; also, in distant batteries against small works they may not perhaps cause much harm; but all this does not prevent their being the most inferior material for revetting. They do better for mortar batteries or traverses and very well for magazines. In revetting with sand bags they should be laid headers and stretchers with a slope of one sixth at least.

GABIONS

Neither are gabions good for revetting a battery (beyond one row on the ground to the height of the genouillère perhaps) on account of the number of joints except in the conversion of a lodgement into a Breaching Battery (see Section VII.) the time and trouble required to lay them to a proper slope, and the great difficulty of repairing them, especially in the embrasures when out of order. They make very good traverses, and are required for masking embrasures. The dimensions for sap gabions need not be adhered to in those required for batteries.

FASCINES

The best revetment is doubtless made of 18 feet fascines 10 inches in diameter, each of these, being long and pliant, will bend to the settling of the earth; they are *quickly and easily applied, present no joints to be loosened by explosion of ordnance,* and unless the fascines are very bad and loosely made, will not catch fire.‡ Those

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* For this and Section XII., written at Ciudad Rodrigo shortly after the siege of Burgos.

† After a few rounds these embrasures become so damaged and open as to expose the gunners considerably, and frequently become choked by the stuff that falls down. It takes upwards of 200 sand bags per gun at first starting only.

‡ A fascine battery (of long fascines) at Messina, made by the Neapolitan Artillery for Instruction, and which had stood for five years and had constant practice from it with heavy guns, was in perfect order. At the siege of Almeida in 1811 the cheeks of the embrasures of stone and of tapia were all injured by the explosion of their own heavy guns; some however that had been opened on the moment and lined with fascines which had been in store a year (and therefore not so good as when green,) stood perfectly and did not burn.

6 or 8 feet in length have not the same advantage, being short, and consequently stiff, they are more likely to be forced out by the swelling of the earth, and their only superiority lies in their portability,—the materials, men and time, being identical in both.

With reference to fig. 1, Plate II., the number of 18 feet fascines for a 2-gun Battery will be

For interior lining	23
For cheeks of embrasures	20
Memorandum.—9 out of the 23 will be cut into short lengths to break joint, &c.	
To which must be added, whatever may be the number of guns,	
For the two epaulements (if 18 ft. long)	18
Also, when traverses are used,	
For additional length, given by their breadth, to the parapet, per traverse	4
	65*

The lower row is sunk about half its diameter in the ground, a trench being cut to receive it.

The first fascine is laid next to one end of the battery, and is picketed down, beginning from that end all but the last picket: this end is let loose, to enable a Sapper sitting across it to hold it up, while three or four of the party, (according to its length,) standing across the second fascine, which they hold in both hands, all fronting the first, after two or three swings drive it well into the first; if not quite even, it must be taken out, and the process repeated, as any error in the first course will be felt throughout.

The other fascines are fixed in like manner.

The interior slope of the parapet is 2 feet, or about a quarter the height.

The pickets to be driven as shewn in fig. 5, Plate I., each *a*, *a*, passing through two fascines; and they are driven till their heads are buried in the upper one. An 18-feet fascine should have seven pickets: the knots of the gads (or withes) to be turned inside; and care must be taken not to drive the pickets into these last, as they are likely to be cut thereby. Pickets may be occasionally driven as *b*, *b*, independently of those as above marked *a*, *a*.

When batteries are near the place, much cover from musketry for the gunners is given by the fascines lining the embrasures being spread like a fan, i.e. vertical at the neck, and sloping at the regular slope of one fourth at the other extremity. The interior ends are to be brought quite flush with the interior (fig. 1, Plate II.) slope of the parapet, as joints near the point of explosion are avoided, and less damage is done if a shot strikes these fascines, than when it disturbs those belonging to the interior of the battery, which by this plan are covered.

The slope given to the sole of the embrasure must depend on the relative level of the object fired at; if for enfilading, it may probably *rise* from the interior to the exterior.

The interior opening at the bottom of a gun embrasure is 22 inches wide; the exterior opening will be regulated by circumstances, but usually, half the thickness of the parapet as a direct embrasure.

In revetting Howitzer Batteries the neck must necessarily be wide, if mounted on a travelling carriage—at least, 2 feet 6 inches,—from the shortness of the piece not

* This, with full allowance for waste, has been observed in Table II., 'Battery.'

allowing it to enter the embrasure when on its travelling carriage In this case all that can be done is, to give the gunners what cover can be allowed consistently with the scope of the howitzer and by the use of the mantlets, if brought within musketry fire after the guns of the place have been silenced

The same remark applies to carronades, which were used occasionally in the Peninsula.

REVETMENT OF MORTAR BATTERIES

These, having no embrasures, require more earth in the parapet The superior slope is reversed They are revetted like other batteries when the materials are abundant, if not plentiful, and the batteries are not seen into from the place, then perhaps a half revetting, as with a row of gabions: if the soil is stiff, it may be dispensed with, but if practicable, revetting is in every way more satisfactory

The centres of the platforms to fire

at 45°	should be	12 feet	from the parapet, when near the place
,, 22°		31 feet	
,, 15°		48 feet	

Thickness of parapets necessary against	Heavy guns	18 feet thick
	12 or 9 pounders	12 or 14 feet
	6 pounders, &c	8 feet
	Musketry . . .	4 feet.

SECTION IX

PLATFORMS.—COMMON OBLONG PATTERN

To lay a Platform well, as used in the last war, the sleepers should lie in trenches, or, at least, as much of their front ends as is required to give them a slope of ½ inch to a foot, the intervals between must be completely and solidly filled in with stones, and brought up flush with earth. If earth alone be used, it must be very well rammed

When three sleepers only can be allowed, as is sometimes done in Breaching Batteries, there must be one under each wheel, and one in the centre The hurter is laid on and fixed to the sleepers The planking is commonly all spiked down to the sleepers, but that mode is noisy, troublesome and renders the removal and use of the materials again difficult

It is best, especially when there are five sleepers, to confine the planking by ribands laid on it, and screwed * through it at three or four points on each side into the outside sleepers below If the screws are well greased before insertion they will bear several removals they should go through the sleepers, and may be fitted with nuts, which last must be uppermost —See Plate III figs 3, 4

Platforms with three sleepers laid parallel, and the planks only 12 feet long, are quite sufficient when the guns are not to traverse, which commonly is not requisite during a siege

Where expedition is not necessary, it is important to have the sleepers well squared, and the planking of uniform thickness

Mortar Platforms, usually 8 feet square, are laid as above but in sandy soils the difficulty of giving stability to the platforms is entirely obviated by the use of a fascine, or junk foundation, in two crossed courses at right angles to each other

The common oblong Siege Platform for guns on travelling carriages, 18 × 12', on

* As recommended also by Sir John Jones in his "Sieges" and used in the last war; but since then Lieut Colonel Alderson, R E proposed a platform which has been found to answer thus far, and of which the subjoined account, p 146, is written by that Officer

five sleepers, even when laid with screws and ribands, instead of the planks being spiked down, weighs upwards of 26 cwt.—Plate III figs. 3, 4

J. F. B.

MADRAS PLATFORM.

The Madras Platform, used in the Indian Army, (Plate III figs. 1, 2,) promises all the efficiency of the above without its disadvantages, weighing only 7 cwt. Attempts have been made to apply the same principle to Mortar Platforms, but hitherto unsuccessfully, as no reduction in weight has been effected in consequence of the great strength necessary for the different pieces. The common mortar platform, 8′ × 6′, on four sleepers, with the same scantling as that for gun platforms, requires wood more readily obtainable, and more convenient for transport. Both this last and the Madras mortar platform weigh about 8¼ cwt.

In constructing the Madras platform care must be taken that the side pieces and transoms make one compact framing, the whole traversing on one front pivot, instead of on two or three, which has been proposed, and which limits the extent of traversing, from the side pieces approaching each other, like those of a parallel ruler, when moved.

All fastenings should be made with screws (instead of nails), which, if well greased when first driven, will admit of the whole being taken to pieces repeatedly. The trail piece, A, is steadied by cleats, and merely drops into its place; it will not be required when garrison carriages are used.

SIEGE GUN AND MORTAR PLATFORMS, INVENTED BY LIEUTENANT-COLONEL ALDERSON, R.E.

1. The object of the construction of the Siege Gun and Mortar Platforms is to place the artillery in battery on hard level surfaces, capable of retaining their position and of enabling the artillerymen to make correct practice with fewer men, from the facility afforded for running the gun or mortar up after each discharge.

2. As these works have generally to be laid under fire, and frequently during the night, the more simple their construction and the more uniform their parts the better.

3. The Gun Platform now to be described, and which has been satisfactorily proved by the Royal Artillery practice at Woolwich, has therefore been made to consist of baulks of uniform length and scantling, which serve for both sleepers and deck.

Each baulk is a piece of fir timber 9 feet long, 3½ inches thick, and 5 inches wide, and weighs about 37 lbs., sufficiently light to be carried to the spot by one man, besides his arms and ammunition, and being universal, it will fit into every part of the platform.

4. This is the *minimum* size, but if made on the spot or in the field the principle may be equally adapted to any other increased dimensions, and thus render available such timber as may be found at the time with the greatest economy of materials and labour.

If constructed of the minimum dimensions above stated a gun platform, 15 feet by 9, will consist of

	cwt.	qrs.	lbs.
46 baulks, with 47 trenails (10 inches long and ¾ inch diameter, each of which makes 4 dowels, 2½ inches long.) 1 oak trenail being added for the rear centre pin of platform . .	15	0	22
9 round iron pins, 11 inches long, including the eye . . .	0	0	18
10 iron shoes, and 20 inch screws	0	1	2
Total weight	15	2	14

Figs. 1 and 2, Plate IV., represent a baulk of the above named dimensions, with eight holes bored 1½ inch deep and 1¼ inch diameter, at the distances specified, four on each of two opposite sides, both sides being alike when taken from opposite ends.

Oak dowels, 2½ inches long and ¾ inch diameter, (four of which are obtained from each trenail,) are then introduced half their length into the holes, on one side of each baulk (figs. 1 and 2,) *a b, c, d*, represent the dowels, and *e, f, g, h*, the holes.

5. Into the end of the dowel which enters the baulk, a fox wedge (fig 3) is introduced to prevent the dowel dropping out The dowel is then 1¼ inch within the baulk, and projecting the same beyond it, this projection fits into the holes of the next baulk

6 In order to lay a gun platform, take any ten of the baulks, and dowel them together two and two, as shewn at c, p, fig 4, each two baulks will then form one sleeper, 15 feet in length.

7 It is to obtain this length that the holes are bored at the distances specified. Two iron shoes, 2 inches broad and ¼ inch thick, are then fitted in, and fixed with a small screw, as shewn in figs 4 and 5, to keep the sleepers steady

8 Fig 6 shews how the sleepers may be made 18 feet in length from the same baulk, should it be requisite, from the nature of the ground, to prevent the trail of the gun recoiling off the platform, which a 32 pounder invariably does with Service charge, when the platform is 15 feet in length, laid with the usual fall to front of ½ an inch per foot.

Each platform requires five sleepers, which must be laid in the space of 9 feet, the width of the intended platform, as shewn in fig 4

9 The platform is now laid in the usual manner, by excavating trenches to receive the sleepers, and, after levelling them with the field level, securing them in their places, by filling in the trench on both sides of the sleeper, and ramming it well, taking great care not to injure the sleeper

10 Prior to commencing the laying the platform holes ¾ inch in diameter must be bored 2½ inches, from one end of each sleeper, and that end is to be placed at the *front* of the platform

11 Next take any one of the baulks and lay it transversely on the ends of the five sleepers, over the holes thus bored, and bore five similar holes through the baulk immediately over them, as shewn in fig 7

12 Place five iron pins through these holes of the transverse baulk, and through the corresponding holes in the ends of the sleepees, the position of the sleepers in front will then be secured.

13 In the rear, a baulk must only be placed over the ends of the sleepers as a guide but without boring either, since the *exact* place for the holes cannot be determined until the last baulk of the platform is laid, because it is not *necessary* that all the baulks should be of one width.

14 When the last baulk of the platform is laid, bore through it and the ends of the sleepers as in front, insert the pins, and the platform is complete

15 The centre *rear* pin is to be an oak trenail, it will then be flush with the platform, and let the trail of the gun recoil without meeting with any impediment

16 The platform thus laid is a clear uninterrupted surface of 15′ × 9, with the exception of the heads of the pins front and rear, a portion of which is shewn complete in fig 4

17 In the construction of this kind of platform the holes in each baulk must be bored at precisely corresponding distances and heights, and this will be easily done by a dowel box, fig 8

k k, k, represent the bottom piece, for which the carpenter's bench, if long enough, may answer

l, the end piece placed transversely

m, m, the front piece through which the holes 1, 2, 3, 4, at the proper distances and height, are to be bored

n, n, the rear piece or cleat

o, o, o o, four wedges to keep the baulk, *r*, close to the front piece

One side of the baulk is then bored through the holes 1, 2 3, 4, with a centre bit, the baulk is then cut off to the proper length by the gauge shewn by the saw kerf at *p*. The baulk is then taken out, turned over, and end for end being replaced and wedged up, the opposite side is bored as before.

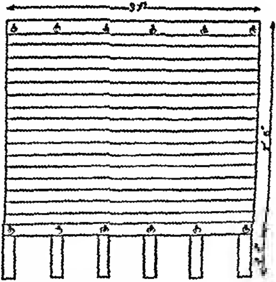
In this way each baulk will be similar in every respect.

18 Iron pins and shoes have been introduced in the construction of these platforms, to enable them to be easier relaid during the siege; but for all the purposes of strength the wooden pins or trenails will answer; and the shoes, excepting in bad ground, may be dispensed with, or made of wood, if required.

19 In taking to pieces a platform thus laid, the wooden pins or trenails must be driven or bored out, and fresh provided if the platform is required to be relaid.

MORTAR PLATFORMS.

Platform for 8 inch and 10 inch Mortars.



Siege Platforms for 8 and 10 inch mortars may also be constructed of baulks and pins of the same dimensions as those which have been described in the construction of Gun Platforms.

A mortar platform of this kind will consist of

		cwt	qrs	lbs
24 baulks	{ 18 as deck 6 as sleepers }	7	3	20
12 iron pins	.	0	0	24
	Total	8	0	16

This will form a platform $9' \times 7' 6''$, the decking can be diminished, or increased to 9 feet square as may be deemed necessary

The ends of the sleepers will necessarily project in a platform of the above dimensions, should they be in the way, they can be cut off where the deck ceases, this will, however, prevent these sleepers from being used in any other description of platforms

This platform has, like the gun platform, been satisfactorily proved by the Royal Artillery at Woolwich.

SECTION X

TRAVERSES

All Batteries of more than three pieces should have splinter proof Traverses to protect the gunners from the effects of shells One between every two guns is generally sufficient They are made about 6 feet thick at base, and about 6 or 7 feet high See fig 5 Plate II

A passage 2 feet wide is left to enable the gunners to get out of the way when a shell falls in the battery, between the traverse and parapet It should extend to the tail of the platforms

If the battery is subject to be enfiladed, even by ricochet, as is very common on the crest of the glacis, the traverses must be at least 10 or 12 feet thick, and such being generally Sunken Batteries, as Breaching and Counter Batteries, the lower part of the traverse is left of the solid ground.

J F B

SECTION XI

MAGAZINES.

The Magazine recommended is that given in figs 2, 3, 4 Plate II., as proposed by Lieut.-General Sir Chas. Pasley

The lean to principle is preferable to that in which the walls are carried up perpendicularly

The baulks should be immediately covered with a tarpaulin, and every precaution taken as to drainage

A magazine of these dimensions will stow at least 64 barrels, or enough for three 24 pounder guns for one day, at 210 rounds per day There should be a separate magazine for every three or four guns though in the same battery; 6 feet in length of magazine per gun is an ample allowance, at the above rate of consumption.

The entrance of the magazine should not be less than 20 or 25 yards in rear of the platforms In 'Blindage,' Plate III fig 4, a section is given perfectly applicable to magazines

J F B

TRACING AND EXECUTION OF A TRIANGULAR FIELD MAGAZINE.

Abridged from Lieut.-General Sir Chas. Pasley's 'Practical Operations of a Siege,' 2nd edition. See Plate II

"This is represented in the annexed diagram, in which the body of the magazine, measuring 19 feet by 8, is supposed to have been laid out parallel to the face of the battery

k, k, k, represent the bottom piece, for which the carpenter's bench, if long enough, may answer.

l, the end piece placed transversely.

m, m, the front piece through which the holes 1, 2, 3, 4, at the proper distances and height, are to be bored.

n, n, the rear piece or cleat.

o, o, o, o, four wedges to keep the baulk, *p*, close to the front piece.

One side of the baulk is then bored through the holes 1, 2, 3, 4, with a centre bit; the baulk is then cut off to the proper length by the gauge shewn by the saw kerf at *q*. The baulk is then taken out, turned over, and end for end being replaced and wedged up, the opposite side is bored as before.

In this way each baulk will be similar in every respect.

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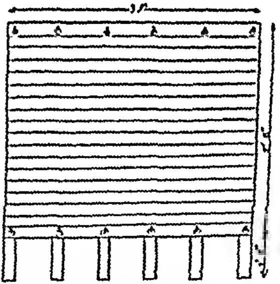
MORTAR PLATFORMS.

Platform for 8-inch and 10-inch Mortars.



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A mortar platform of this kind will consist of

		cwt	qrs.	lbs
24 baulks	18 as deck; 6 as sleepers	7	3	20
12 iron pins	. . . . . .	0	0	24
Total		8	0	16

This will form a platform 9′ × 7′ 6″; the decking can be diminished, or increased to 9 feet square as may be deemed necessary

The ends of the sleepers will necessarily project in a platform of the above dimensions, should they be in the way they can be cut off where the deck ceases, this will however, prevent these sleepers from being used in any other description of platforms

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If the battery is subject to be enfiladed even by ricochet, as is very common on the crest of the glacis, the traverses must be at least 10 or 12 feet thick, and such being generally Sunken Batteries, as Breaching and Counter Batteries the lower part of the traverse is left of the solid ground.

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A magazine of these dimensions will stow at least 64 barrels, or enough for three 24 pounder guns for one day, at 240 rounds per day There should be a separate magazine for every three or four guns though in the same battery 6 feet in length of magazine per gun is an ample allowance at the above rate of consumption

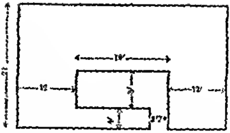
The entrance of the magazine should not be less than 20 or 25 yards in rear of the platforms In 'Blindage' Plate III fig 4, a section is given perfectly applicable to magazines

J F B

TRACING AND EXECUTION OF A TRIANGULAR FIELD MAGAZINE

Abridged from Lieut.-General Sir Chas. Pasley's 'Practical Operations of a Siege,' 2nd edition. See Plate II

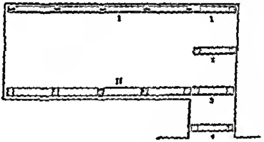
' This is represented in the annexed diagram in which the body of the magazine, measuring 19 feet by 8 is supposed to have been laid out parallel to the face of the battery



"In preparing to place the frame-work of the body of the magazine, the two sleepers for receiving the stanchions and struts were laid parallel to each other, at the clear distance of 6 feet 6 inches apart, in grooves properly prepared, the former being laid horizontally, and the latter at an angle of 45 degrees. These occupied about 15 feet of the length of the excavation of the body of the magazine, the rest of which belonged to the passage

"When the *two sleepers were laid, and the stanchions* and *struts* were connected with each other, and fitted to their respective sleepers by pairs as soon as possible, and the stanchions were secured by wedges or otherwise, to keep them steady for the present, — the four passage frames were then placed, one in the direction of the stanchion sleeper produced, the other parallel to it, at the distance of about 11 feet to the rear, that is, a little in front of the alignment marked for the front of the rear trench the other two were then set up at equidistant intervals between these two

"This arrangement is represented in the annexed figure, in which the Roman numerals I and II represent the two sleepers, shewing the mortises or notches for the stanchions and struts of the frame work of the body of the magazine, whilst the numeral figures 1, 2, 3, and 4, shew the positions of the passage frames



"The *sheeting planks* were then introduced between the stanchions of the body of the magazine and the side of the vertical excavation adjacent, until the whole of the sunken part of the magazine was lined with woodwork on that side after which the upper was revetted by about three courses of fascines; the sheeting and fascines together being so arranged as just to cover a space of about 6½ *feet in height from* the sole of the excavation upwards The splinter proof timbers were then laid, in the intervals between the triangular frames of the body of the magazine, with the foot of each resting on the strut sleeper, and the top of each lying against the uppermost course of fascines At the same time, the extreme end and the *two sides of the pas* sage were lined with sheeting planks, excepting of course that part of one side which was left open to communicate with the body of the magazine The whole passage, including the extreme end of the body, was there covered by splinter proof timbers laid horizontally over all the caps, which being done, the timbers were to be covered by tarpaulins

"In placing the sheeting, fascines, and timbers, the whole of the men were required to hand those materials which had previously been laid near the spot. As soon as the above were disposed of, the labourers' work again proceeded until the magazine was finished. About three, and not exceeding four, men were employed as rammers, the remainder as diggers and shovellers. In consequence of its being impossible to dispose of all the first excavated portions of earth properly, until the magazine was covered in, as many men as possible were employed as shovellers, by whom the loose earth, especially that in rear of the magazine, was thrown upon the parapet, until it attained the dimensions specified."

For dimensions of the magazine see Plate II figs 2, 3, 4

SECTION XII.

REMARKS ON SIEGE BATTERIES, FROM NOTES OF LIEUT.-GENERAL SIR J. F. BURGOYNE, G.C.B., R.E.

The most difficult operation of a Siege is the execution of Siege Batteries, and requires the best Officers to be employed.

It is here that regularity and system are most particularly necessary to arrange the men and stores in such manner that there may be no delay and confusion.

The quickest mode of making a battery (though but of rare occurrence) is by raising the parapet entirely of materials brought from a short distance in baskets, or with wool packs and sacks of earth, &c., thrown in. In this way, the revetting and laying platforms, can be commenced at once, but the mode is only applicable to a small quantity of work, such as a single battery for a few guns; and even then, the working party must be very strong, the arrangements good, the baskets numerous, and the supply of earth near at hand and abundant.

The next quickest is the Half sunken Battery, in which the earth is got partly out of the interior (excavated to about 18 inches deep), and partly from the ditch. This may be expeditiously done, the stuff for the parapet being sooner obtained. The most usual mode, however, is to raise the battery entirely above ground by excavating from the ditch.

The longest and most inconvenient method is that of the Full sunken Battery, where the interior is sunk to the depth of the genouillère, unless the ground, by falling immediately from the back of the parapet, prevents the excavation being so very great before the platforms can be laid, as it must be in level ground. In executing this sort of battery, care must be taken that the natural ground does not interfere with the fire of the guns, and a very slight swell will do this.*

If the Battery is on the side of a hill sloping towards the place, the work in the interior will become excessive; as happened at the siege of Ciudad Rodrigo, where, at the tail of the platform, the depth to be excavated was 6 or 7 feet.

ELEVATED BATTERIES BUILT ON THE NATURAL SURFACE OF THE GROUND

The best, the ordinary, and safest mode—that of excavating the whole from the ditch—may be done thus:

The foot of the interior slope of the parapet (which is the regulating line in all instances) is first accurately laid out, then a parallel line, at the distance of 22 feet, gives the interior edge of the ditch, Plate I fig 1

---

* Lieut. General Sir Chas. Pasley very judiciously recommends, in determining the position of a Gun battery for direct firing, that in tracing a battery the person should kneel or lie down, looking towards the fortress, in order to guard against the inequalities of ground, and to be certain that the guns can hit the object.

The workmen to be placed along the ditch on the line *a*, 4 feet apart, or 5 men per gun

The depth of the ditch to be 6 feet, to obtain the earth for the parapet, and the task, (if that system be adopted, and particularly if they have a double set,) which may well be 4 feet wide and 6 feet deep, should be complete in 24 hours But as that would bring it to a finish at night (batteries being nearly always commenced at dusk), the additional hours to next morning will afford ample time

A party of 3 men per gun to be on the berm to throw forward the earth for the parapet, and give a good backing to the interior revetment; they must keep the berm *perfectly clear* all night: this is a point of great consequence, and most particularly to be attended to, because these men, being more exposed, are more liable to shrink from their work At morning the whole of the earth should be close to the interior revetment, and not a particle of it on the berm, which can only be done by keeping the men at this work from the first, and not putting it off till the morning they should also have a relief, or double set, or, in other words the working party should all take their turn in this dangerous duty

Three men per gun will also be necessary for ramming the earth well, particularly near the interior of the parapet this also is a point of great consequence, and very apt to be much neglected, the earth settles exceedingly from the concussion of the firing, so much so, that the merlon will sometimes be seen almost entirely settled down, and leaving the revetting of long fascines standing nearly by itself In Sand-bag Batteries (where those flimsy materials—sand bags—are soon demolished), the embrasures choke, and the merlons settle so that the crest of the parapet is soon reduced to a waving line, at most not more than 5 feet above the ground

At one end of the battery, a narrow ramp must be made to communicate with the ditch, and enable the reliefs to pass under cover

The attention of the Officers will be much required,

1st To the men in the ditch, that they work hard, and do not cut away from the escarp, which they are apt to do

2nd To the men on the berm, and rammers, that they remain steady at their post and work.

With these, and the bringing up the various stores *in time*,—revetting the battery,—laying platforms,—and making magazines, Battery duty becomes a most arduous undertaking, and one that requires nice management to be completed with expedition

The French mode of excavating the ditch in the shortest time is by a second row of workmen, 6 feet from the first, not covering but chequered with them thus, instead of placing one row of men 3 feet apart, which would be crowded each alternate man is moved out in another line 6 feet from the first, then, the whole working in one direction from the battery, there will be room for the second row to throw the earth through the intervals of the first But independently of the difficulty (which they acknowledge) of carrying this into execution in the night, and perhaps under fire, the excavations will be inconvenient to work in on the following day Hence a single row, 4 feet apart, is preferable

HALF SUNKEN BATTERY

In the execution of these, a row of men, 4 feet apart, will be wanted for the excavation of the interior of the battery, which may be about 18 inches deep These men will be occasionally interrupted as the revetting goes on, but not seriously so The first row of fascines may be laid before the excavation is commenced it being understood that the fascines of the excavated part are to supersede the hurter of the platform

The guns must be all ready, with a good access made to the battery, that they may

be run in during the last hour or two of dark, when they will be against the merlons till the platforms are laid.

FULL-SUNKEN BATTERY

It would appear, at first sight, in these, that having nothing to raise but the merlons, the work would be much diminished, but the sinking of the whole interior to a depth of 3 feet, with a sufficient passage to the rear, leads to greater labour than that of raising the parapet entirely from the ground, since a Sunken Battery must have a width of about 30 feet, not to be very crowded and inconvenient * The earth that will about complete such a battery will be had at the depth of 2 feet 6 inches, or 3 feet, by which we gain that height of solid parapet formed of the natural ground, and a somewhat speedier cover for the men, but the inconveniences are so great on service, that it cannot be approved of, or considered even the quickest way, for the following reasons

1st The men will cut the 1st trench to the depth of 3 feet to gain cover, 6 inches of which must be afterwards filled in again

2nd As the excavation enlarges, the distance to throw the earth becomes great, and indeed requires an additional row of men

3rd No platforms can be laid, nor traverses made, nor the revetment carried on, nor even materials brought in, until the excavation of much of the interior space near the parapet is finished hence not nearly so many men can be employed at the same time as in a battery entirely raised from the ground, and the materials taken from the ditch where all things may go on together

4th. When a parallel is to be converted into such a battery,—the most common case in which it occurs —the parapet must be made up solid, and the embrasures cleared out afterwards † as this the excavation becomes considerable which may be easily conceived by adding to the bulk of the embrasure (as finished) that at the cheeks which must be removed to obtain a foundation for the lining, and remembering that the newly thrown up earth is so loose even when rammed, as to require a great slope to stand whilst the revetting goes on the consequence is that in the impatience to open them which appears at first but a trifling operation they are almost invariably badly done —in irregular directions,—and the mouth of the embrasure never so open or so low as it ought to be

5th The foundation will be so uneven that the laying of the platforms becomes tedious and is very frequently ill done

6th The interior of the battery is difficult to drain, always confined, and shells are caught by the reverse slope of the excavation

7th. Magazines, being on the level of the natural ground, are not so well covered by the parapet

The principal case where this mode may be advantageous and time gained is where *a parallel has been made, and part of it is to be converted into a battery instead of* commencing a fresh one in front in this instance a considerable part of the work is already executed, and may be continued during the day, whilst a new communication is being made round its rear;—it is thus that the battery may be said to be quickly executed, counting from the time of commencing its conversion to a new purpose

* When the fire of the place is still able to plunge into the battery even this may not be allowed, as the rear becomes so much exposed

† An evident loss of time and an inconvenient practice: it can only be of service when the battery is to be thrown up some time before it is opened and the position rendered imperative by circumstances

These remarks suppose the natural ground to be level and perfectly open in front, without any impediment to the fire: if it falls greatly to the rear, there is a great advantage in sinking the interior On the crest of the glacis there are many reasons that make it necessary. (Plate I fig 6.) If the ground rises to the rear, excavation is unavoidable, but the labour is enormous.—See Plate I. fig 4

As in Full-sunken Batteries the natural *ground forms the sole of the embrasure*, it cannot (when level, or rising towards the place) be cut away to admit of guns being depressed, as required in Breaching and Counter Batteries, where the platforms may even have to be raised. When this necessity for depression can be foreseen, care must be taken to leave the bottom of the trench higher than at other points. It is always easy to reduce, not so to replace.

Note.—The preceding details refer to Batteries perpendicular to their line of fire, or nearly so It seldom happens that they *are required with such an obliquity as to* render a Crémaillère Battery necessary, except on dykes and banks of rivers. At Salamanca, one instance occurred during the late war; but there it was cut out of a heap or bank of ruins,—thus greatly simplifying the operation, which, when this description of battery is built and revetted from the ground, becomes extremely troublesome. *It has however one advantage, that traverses are not so necessary.*

SECTION XIII.

POSITION AND CONSTRUCTION OF FIELD BATTERIES.

The position of Batteries ought always to be on the most commanding and most advanced points, in order *to discover* the country to the *greatest* possible distance, and to produce *a cross fire* on that space which the *enemy* would have to march over in attacking the position.

If there be in front any road or passage which the enemy would be obliged to follow, or any grove of trees which there is not time to fell, or any kind of cover whatever which cannot be removed for want of time and means —we must begin by marking the place for a certain number of pieces to bear on these objects in proportion to the whole number of which the battery is to be composed, not forgetting those which are necessary to produce a *cross fire corresponding* with the *other* batteries.

However, in the uncertainty in which we must be with respect to the manner in which the enemy may form his attack, and how he may dispose his line or columns, it is always advisable to mark some embrasures more than there are guns in the battery.

It does not always happen that the position commands all *parts of the* country in *front and on the flanks,—on the contrary, frequently,* whether on the *front* or flanks, the position *may be on the edge* of a valley intersected by a *river or rivulet*, the passage which it is necessary to *defend*; and the opposite banks are of the same height, and not more than 800 or 900 paces distant *In this case*, in advancing on the salient points, the first attention *is to preserve, at least equality of height with* the opposite bank. *But* if the *slope* in front be not regularly *formed* en glacis, but uneven or forming a double slope, the *consequence* is that from our position we can *not discover* all the ground in front;—it will be necessary to *take* down the guns to that part of the slope that *sees* the whole of the valley *As this* will be commanded by the opposite ground, and there is little time to cover the guns sufficiently, we must erect also a battery in its rear for our heaviest guns to bear on the opposite spot most *favourable to the enemy preserving* an equal height, *or greater*, if possible.

Having established the principal battery, it is then necessary to take into consideration the principal debouches of which the enemy might make use; namely the

great roads, bridges which cannot be destroyed, or for some reason are preserved, and the places where he is most likely to cross either by fording or pontoons

When the ground of the position is not en glacis, and from the summit we cannot defend the slope in its whole length to the bottom of the valley, irregularities of the ground must be taken advantage of to obtain a cross flanking fire But it is indispensable that the battery be covered by traverses from the fire of the opposite ground, avoiding at the same time being commanded within grape

The use of traverses being only applicable to works intended to *flank* the bottom of the hill it may be necessary to dispute the passages by a direct fire from a battery half way down the hill: this can only be done by raising parapets to a sufficient height to cover the carriage in its whole length, so that it can only be seen through the embrasure, which need not be very large, as it is intended to bear on only one passage.—(See Profile No. 1, Field Battery)

The most expeditious method to form these batteries is to take the level of the ground for the sole of the embrasure.—(See Profile No 2)

The Artillery thus placed in advance will *retire*, after having defended these approaches through the intervals of the line of position

If the irregularities in front of the position are not very considerable, instead of advancing down the hill it will sometimes be sufficient to raise the guns 2 or 3 feet (see Profile No 3) to discover the whole of the slope and see the enemy everywhere This will be preferable, particularly when we cannot so advance without subjecting ourselves to command from the opposite heights, which occasions great labour in forming traverses and sinking trenches, to remedy the evil of being commanded at a small distance.

Construction.—Profile *

The Thickness of parapets against musketry need be only 3 or 4 feet.

To resist cannon at a distance of 1200 paces 9 feet will be sufficient, and in all cases, and at the nearest distances, 12 feet will resist the nearest artillery used in the field.

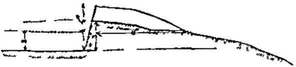
The Height of the parapet above the platform in front of the gun cannot exceed 3 feet, but in the space between it is raised to 4 feet 4 inches,—this relates to ground not commanded.—(See Profile No 4)

When commanded the parapet must be raised or traverses formed, as circumstances may require.

The four following profiles are of the description required in the field for Batteries

Profile 1

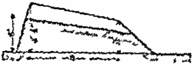
Profile 2



* See Genou Ilère *

Profile 3

Profile 4



BATTERY TABLES.

In the following Tables no difference is made with reference to labour, tools, and materials in the description of Battery, whether Elevated, Sunk, or Half-sunk, one sufficient allowance being made for all in any soil except hard gravel or rock: 20 feet length of parapet per gun, or 23 feet per mortar, is allowed for each piece, and is taken, with its labour, tools, and materials, as the unit. A like quantity is assumed for each epaulement, and one third for each traverse, on account of *additional* labour, &c, in the extra length of parapet it entails, as well as in its own construction: in *Breaching* and *Counter Batteries* ⅓rds per traverse is given.

The gun and mortar are placed on the same footing, as the work in the 3 extra feet in the latter may be set against that in the embrasure of the former Full allowance is made for waste in fascines and sand bags: the apparently excessive demand for the latter is, however, the result of much experience in the field.

In *Gabion Batteries*, a full revetment of gabions has been omitted as objectionable; but as there are cases when enough may be obtained for one row on the ground, and the rest completed with fascines or sand bags, provision has been made for this in Table II

BATTERY TABLE I

DIMENSIONS FOR SIEGE BATTERIES

	ft.	in		ft	in
Thickness of parapet at top .	18	0	Slope of platform . per foot	0	0¼
Height of parapet* . .	7	6	Interior slope of parapet — from ¼th to ⅓rd height	"	
Distance of embrasures from centre to centre . . .	20	0	Superior slope per foot	0	1
Interior opening of embrasure	2	0	Ditto mortar batteries, when reversed per foot	0	1
Exterior ditto (= ½ thickness of parapet) .	9	0	Exterior ditto mortar batteries, if not revetted, per ft	1	0
Height of genouillere, for travelling carriage .	3	0			
Height of genouillère, for garrison carriage . .	2	3	Distance of traverse from parapet	2	0
Width of berm	3	0	Length of traverse = that of platform	"	
Depth of ditch . . .	6	0			
Width of ditto at top . .	24	0	Breadth of traverse at base	7	0
Ditto ditto at bottom .	12	0	Ditto ditto at top .	4	0
Platform for travelling carriage Length	18	0	Length of epaulement, — sufficient to protect the rear of the battery . .	"	
Breadth	12	0			
Ditto for garrison carriage Length	15	0	Mortar platforms, from centre to centre . .	23	0
Breadth	12	0			

* In Half-sunken Batteries, 8 ft 6 in or 6 ft. In Sunken Batteries 8 ft

BATTERY TABLE II

CONSTRUCTION OF BATTERIES FOR THE DESTRUCTION OF THE DEFENCES

	Labour, Tools, and Materials for Parapet, Epaulements, and Traverses; not including Platforms or Magazines.	Rates per Gun or Mortar in the Unit	2 Guns and 2 Epaulements.	2 Guns and 2 Epaulements	4 Guns 2 Epaulements, and 1 Traverse	6 Guns 2 Epaulements, and 2 Traverses
		Unit.	Unit × 4	Unit × 5	Unit × 6⅓	Unit × 8⅔
	FASCINE BATTERIES					
Labour	Sappers, or Acting ditto; Revetters . .	3	12	15	19	26
	Line; Diggers, Shovellers, Rammers, and Assisting Revetters	15	60	75	95	130
	Total labour . .	18	72	90	114	156
Tools	Pickaxes	5	24	30	38	52
	Shovels	12	48	60	76	104
	Rammers	3	12	15	19	26
	Hand saws	1	4	5	6	8
	Fascine mallets	3	12	15	19	26
	Tracing pickets for embrasures, 4 feet long	2	4	6	8	12
	Small ditto } per Battery	20	"	"	"	"
	Crow-bar } per Battery	1	"	"	"	"
	50-feet tape } per Battery	1	.	"	"	"
	Field level } per Battery	1	"	"	"	"
Materials	Fascines, 18 × 10″ diam* { Revetting parapet and embrasures }	24	96	120	152	208
	Fascines, 18 × 10″ diam* { Revetting end of each epaulement }	(12)	24	24	24	24
	Pickets for ditto, 4 feet long	168	840	1008	1232	1624
	Gabions for traverses 3 ft. high × 2 ft. diameter	"	"	"	48	96
	SAND BAG BATTERIES					
Labour	Sappers, or Acting ditto; Revetters .	3	12	15	19	26
	Line, Diggers Shovellers Rammers and Fillers	18	72	90	114	156
	Total labour . .	21	84	105	133	182
Tools	Pickaxes	6	24	30	38	52
	Shovels	15	60	75	95	130
	Rammers	3	12	15	19	26
	Hand mallets	6	24	30	38	52
	Tracing pickets for embrasures, 4 feet long	2	4	6	8	12
	Small ditto } per Battery	20		,		
	Crow bar } per Battery . . .	1	.	"		"
	50 feet tape } per Battery . . .	1			"	,
	Field level } per Battery	1	"			
Materials	Sand bags, 1 bushel { Revetting parapet and embrasures }	800	3200	4000	5067	6934
	Sand bags, 1 bushel { Revetting end of each epaulement }	(300)	600	600	600	600
	Gabions 3 × 2′ diameter	.		,	48	96
	(Sand bags for traverses if gabions cannot be had)	.	"	"	600	1200
	GABION* BATTERIES—UPPER HALF FASCINE Labour and Tools—See "Fascine Batteries"					
Materials.	Gabions 3 × 2′ diameter	12	48	60	124†	200†
	Fascines 18 × 10′ { Revetting parapet and embrasures }	17	68	85	108	148
	Fascines 18 × 10′ { Revetting end of each epaulement }	(12)	24	24	24	24
	Pickets, 4 feet long	119	644‡	763‡	924‡	1024‡
	UPPER HALF SAND BAG Labour and Tools—See "Sand bag Batteries"					
Materials	Gabions 3 × 2 diameter	12	48	60	76	104
	Sand bags, 1 bushel { Revetting parapet and embrasures }	600	2400	3000	4400†	6400†
	Sand bags, 1 bushel { Revetting end of each epaulement }	(300)	600	600	600	600

* Or cask. Beef and pork tierces or rum hogsheads give dimensions nearest to those of the gabions
† Including for traverses ‡ Including for the ends of the epaulements

N B—For Communications with the Parallel—add per 3 ft in length 1 labourer 1 tracing fascine 1 pickaxe 1 shovel

BATTERY TABLE V.—See Plate III.

	Labour, Tools, and Materials for laying (only) Platforms in Gun and Mortar Batteries.				Per Gun or Mortar, as Unit.	Guns or Mortars. 2	3	4	6
	COMMON OBLONG PATTERN.								
Labour.	Carpenters				2	4	6	8	12
	Labourers, cutting trenches, &c. &c.				2	4	6	8	12
	Total labour . . .				4	8	12	16	24
Tools.	Adzes				1	2	3	4	6
	Axes, broad				1	2	3	4	6
	" pick				2	4	6	8	12
	Augers, ¾ in.				2	4	6	8	12
	Levels, field				1	2	3	4	6
	Rammers, earth				2	4	6	8	12
	Saws, hand				2	4	6	8	12
	Spades				2	4	6	8	12
	Wrenches, screw				2	4	6	8	12
		Scantling. Gun.	Mortar.						
Materials.	Hurters	12′	"	× 6″ × 6″	1	2	3	4	6
	Sleepers	18′	8′	× 6″ × 5″	5	10	15	20	30
	Planks	12′	8′	× 1′ × 3″	18*	36	54	72	108
					8†	16	24	32	48
	Side ribands	18′	8′	× 9″ × 2″	2	4	6	8	12
	Screw-bolts (10″ × ¾″) and nuts				10*	20	30	40	60
					8†	16	24	32	48

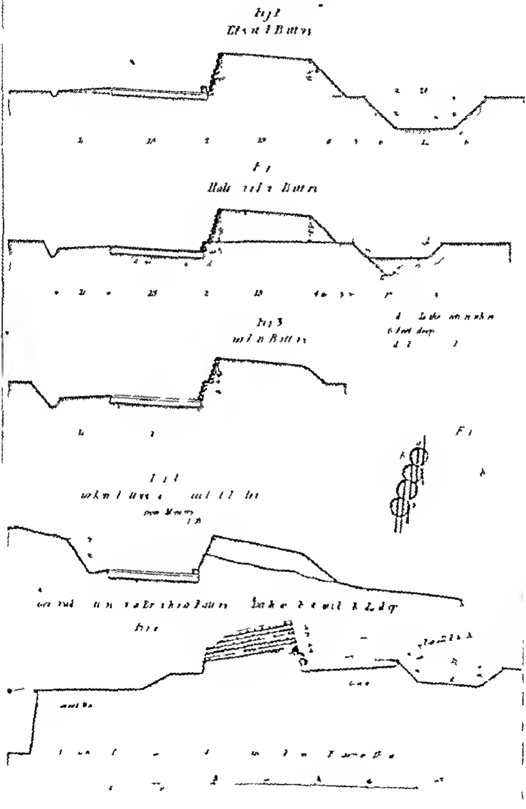
* Gun platform. † Mortar platform.

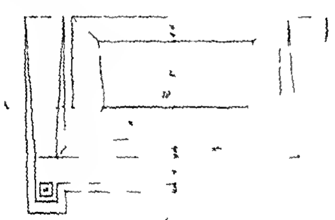
BATTERY TABLE VI.

MADRAS PLATFORMS.—See Plate III.

	Labour, Tools, and Materials; laying only.	1 Gun or Howitzer.	2	3	4	6
Labour.	Carpenters	2	4	6	8	12
	Labourers, cutting trenches, &c. &c. .	2	4	6	8	12
	Total labour . . .	4	8	12	16	24
Tools.	Axes, broad	1	2	3	4	6
	" pick	2	4	6	8	12
	Augers, ¾-inch	2	4	6	8	12
	Hammers, claw, large	1	2	3	4	6
	Levels, field	1	2	3	4	6
	Mallets, hand	1	2	3	4	6
	Rammers, earth	2	4	6	8	12
	Screw drivers	2	4	6	8	12
	Spades	2	4	6	8	12
Materials.	Side pieces, complete	2	4	6	8	12
	Trail piece, ditto	1	2	3	4	6
	Head piece, or front transom	1	2	3	4	6
	Transoms, centre and rear	2	4	6	8	12
	Sleepers, 10 ft. long	1	2	3	4	6
	" 8 ft 3 in	1	2	3	4	6
	" 6 ft. 6 in, and pivot . . .	1	2	3	4	6
	" 6 ft.	1	2	3	4	6
	Iron tie bolt and nut	1	2	3	4	6
	Screws—5-inch; No 23	24	48	72	96	144

SECTIONS OF SIEGE BATTERIES





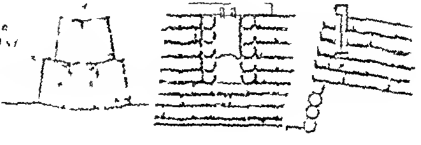
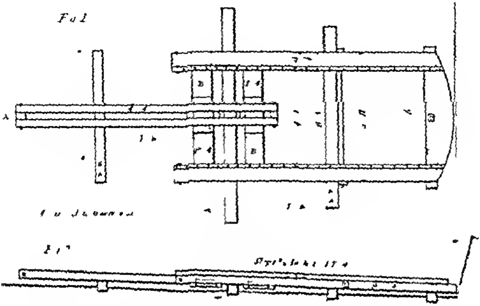


Fig 1 — MADRAS PLATFORM



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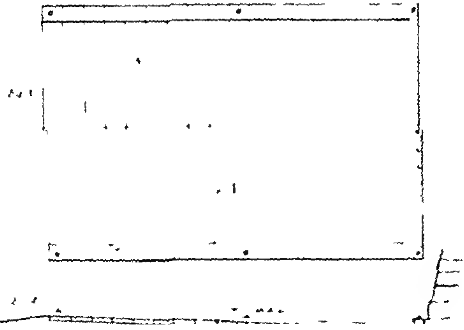
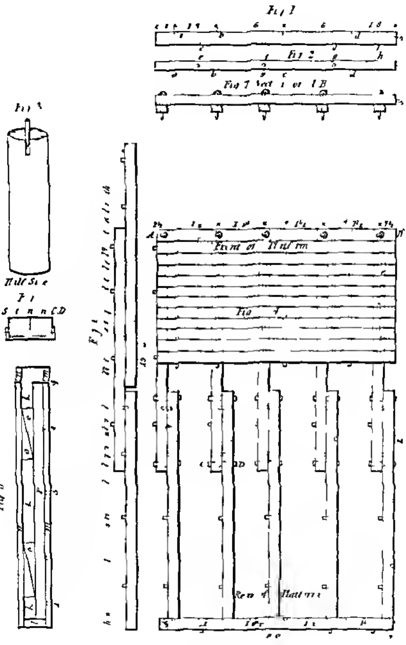


SIEGE GUN PLATFORM



BATTERY TABLE VII

LIEUT COLONEL ALDERSON'S GUN PLATFORM SEE PLATE IV

	Labour Tools and Materials laying only	1 Gun or How'tzer	2	3	4	6
	18 FT PLATFORM FOR GUNS ON TRAVELLING CARRIAGES					
Labour	Carpenters	3	6	9	12	18
	Labourers cutting trenches &c. &c.	2	4	6	8	12
	Total labour	5	10	15	20	30
Tools	Axes broad	1	2	3	4	6
	pick	2	4	6	8	12
	Augers ¾ inch	2	4	6	8	12
	Gimlets (to 1 inch screw)	2	4	6	8	12
	Hammers claw large	1	2	3	4	6
	Levels field	1	2	3	4	6
	Mallets hand	2	4	6	8	12
	Mauls pin	1	2	3	4	6
	Rammers earth	2	4	6	8	12
	Screw drivers	2	4	6	8	12
	Spades	2	4	6	8	12
Materials	Joists	54	108	162	216	324
	Dowels	216	432	648	864	1296
	Iron pins	10	20	30	40	60
	Iron shoes	10	20	30	40	60
	Screws to ditto 1 inch (No 205)	20	40	60	80	120

BATTERY TABLE VIII

LIEUT COLONEL ALDERSON'S 8 AND 10 INCH MORTAR PLATFORM

SEE PAGE 148

	Labour Tools and Materials; laying only	1 Mortar	2	3	4	6
Labour	Carpenters	2	4	6	8	12
	Labourers cutting trenches &c &c	2	4	6	8	12
	Total labour	4	8	12	16	24
Tools	Axes broad	1	2	3	4	6
	pick	2	4	6	8	12
	Augers ¾ inch	2	4	6	8	12
	Hammers claw large	1	2	3	4	6
	Levels field	1	2	3	4	6
	Mallets hand	2	4	6	8	12
	Mauls pin	1	2	3	4	6
	Rammers earth	2	4	6	8	12
	Spades	2	4	6	8	12
Materials	Joists	27	54	81	108	162
	Dowels	108	216	324	432	648
	Iron pins	10	20	30	40	60

BLINDAGE.

Prior to the Wars of the Revolution, Cormontaingne's section, Plate I. *fig.* 1, seems to have been regarded as the model.

But the difficulty and expense of procuring such a quantity of 12-inch plank as would be required for a tolerably large garrison, and the inconvenience and labour in managing such weighty beams, suggested to M. de Sénarmont the arrangement given in *fig.* 2. *Though it has not been tested by experiment, those hereafter detailed leave no doubt as to its sufficient strength; it is given here as worth recollection when only small scantling can be obtained; but it must be well bridged and stiffened laterally;* and it is recommended that about one plank in ten be let a foot into the wall, at each end, as at *a*, *fig.* 4.

By the experiments at Douay, in 1826-29, it appears that with reference to

HORIZONTAL BLINDAGE,

1st. A single course of naked contiguous beams 12″ × 12″, with a bearing of 16½ feet, is *not* proof against shells* at a range of 670 yards; it may stand the first shell, but not a second on or near the same place.

2nd. Neither is such a course of beams secured by a single layer of fascines, brushwood, &c., as no lateral resistance is made to the shell, which easily pierces through this covering.

3rd. *But one such course is perfectly proof when covered by two layers of fascines*, crossing each other (without any earth or dung); or even by 2½ feet of dung, without fascines.

4th. Also, one course of such beams, 6 inches apart,† is proof, if covered with two of crossed fascines; or one of fascines, and 40 inches of earth; or by a course of baulks 12″ × 12″, laid touching each other.

SLOPING BLINDAGES.

Baulks 20′ 6″ long, 12″ × 12″, 6 inches apart, and naked, are not proof; neither are they so with one layer of fascines; but they are perfectly so when covered with a course of contiguous beams of the same scantling; or by a bed of earth, from 3′ 6″ to 6′ thick, as in fig. 4, Plate III.

The blindages that resisted the shock *of the shell were all proof against the bursting*, the action of which last seemed much less energetic than that of the shock. This, it is to be observed, is an important principle in the construction of casemates.

Hence, *all* blindages may be considered proof if made of 12″ × 12″ scantling with a bearing of 16½ *feet, and covered with two crossed courses of fascines*, or with 3 to 6 feet of earth; or with a second course of contiguous beams, also 12″ × 12″. The latter would, however, occasion a great consumption of materials not easily provided.‡

This conclusion is supported by the fact, that at the siege of Antwerp in 1832, a mortar battery 18′ × 12′ in the clear, roofed with one course of 6½″ to 7½″ spars, three courses of fascines, and 3′ to 4′ of earth,—on side walls of five stanchions 8″ × 10″, and 8-inch framing,—stood proof, though struck by many shells; whilst a gun battery, built in like manner, except that no provision was *made against the side thrust* of the shells, fell at the first blow, and disabled the gun beneath it. There are other

---

* Size and elevation not given; presumed from the context to be 8-inch shells at 45°, at least.

† An 8-inch shell would find its way through, if farther apart.

‡ See "Field Fort."

precedents and experiments recorded by Djolceck in his 'Taschenbuch,' on the requisite strength for blindages against 11-inch shells, but there is nothing in contravention of the principles laid down above

Blindages made with Small Scantling

The following experiments were also made at Douay:

1. Two courses of 5″ 6 × 5″ 6 scantling, 20′ 6″ bearing; the pieces 6½ inches apart, and covered by one layer of fascines, without earth

2. Ditto, but the pieces in the lower course contiguous

3 One course of 5″·2 scantling, with 18′ 3″ bearing; pieces touching each other, covered with a bed of saucissons, and 40 inches of earth

Nos. 1 and 2 were penetrated by shells* at 890 yards

No 3 was broken by only two shells out of the fifteen that reached it; hence it is too weak, but the experiment is sufficient to shew that small scantling may be used when larger timber cannot be had

In the following, the preceding data have been assumed as the basis of construction

Blindages may be required for Batteries, Magazines, Stores, Hospitals, or Barracks

When for Gun Batteries, Plate II gives the details of behind a full parapet The side farthest from the enemy only is made splinter proof by 6 inch scantling, wedged in between the stanchions, as at *e*, fig 2, and the whole secured by gallons The struts, *f*, are indispensable to resist the side thrust of the shells The heart of the outer side, *g*, is built up with dry rubble to relieve the planking from the lateral pressure.

When a Battery is to be placed behind a Barbette Parapet, such as A e, fig 2, Plate III, perhaps only 18 feet thick, there will be some difficulty in forming a face for the height above the low crest, e, that would be proof if formed of ordinary timber, as was done at the siege of Dantzic, (vide Laisne, 2nd edit p 421,) and as given in the 'Aide-Mémoire à l usage des Officiers d Artillerie' 1844, it could scarcely be less than 8 or 9 feet thick, and would thus occasion considerable waste It is therefore best, in this case, to complete the barbette section to that of the full parapet as given in Plate II, by withdrawing 24 feet from the cordon, so as to have 18 feet thickness of parapet and 6 feet exterior slope, revetting the interior of the parapet and the cheeks of the embrasures as shewn in figs 1, 2, Plate III We are then in the position of Plate I, and the blindage can be completed exactly as before The thickness, *d d*, must depend on the fire, either direct or oblique, to which the battery will be exposed

This blindage is intended only to be placed where it is not exposed to direct fire and has been seldom used except in such positions, but experiments on the Continent have proved that by laying beams 12″ × 8″ over a portion of the embrasure, and covering them with earth 4 feet thick, a protection is thus formed in front of the roof of the blindage which enables it to resist a great deal of direct fire, and renders it much more secure against shells

In Djolueck's 'Taschenbuch' some account is given of a Blinded Mortar Battery used at Antwerp, 1832, but not with sufficient detail to enable a drawing to be made It was probably the Gun Blindage, open at both ends, much on the principle of the casemated mortar batteries at Coblenz, which are little more than bomb proof piazzas

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* Size and elevation as before not specified, neither is the nature of the timber in the account of these experiments in the 'Aide Mémoire à l usage de l Artillerie' 1844 oak is mentioned, but it is shewn above that the sections Plates II and III are strong enough

For Magazines attached to Siege Batteries, see 'Battery.' When they, or stores, are to be placed in houses for defence of places, dry cellars will be best, *properly protected above.*

Blindages for Hospitals or Barracks are best made in low strong buildings, with walls, if possible, not less than 3 feet thick, though this seldom occurs but in ecclesiastical or other public buildings, where however the walls are lofty. If a low second story can be arranged under the same cover, so much the better When blindages are to be inhabited, the sand, earth, &c, should be kept from falling through by a course of sand-bags, as at *g*, fig 3, Plate I.

Splinter-proofs, either for hospitals, barracks, or stores, can be made, as in Plate III fig 3, wide enough for a man to lay down in, at the rear of the retaining wall of a rampart, or against the counterscarp, on a side not likely to be attacked When, however, the site can be reached by shells, or when a magazine is wanted, fig 4, Plate III, is the smallest that can be advisably constructed.

If a building has to be blinded horizontally, as in Plate I, the external abutments can be obtained by running the splinter-proofs or bomb proofs round it, that will be required for barracks, &c

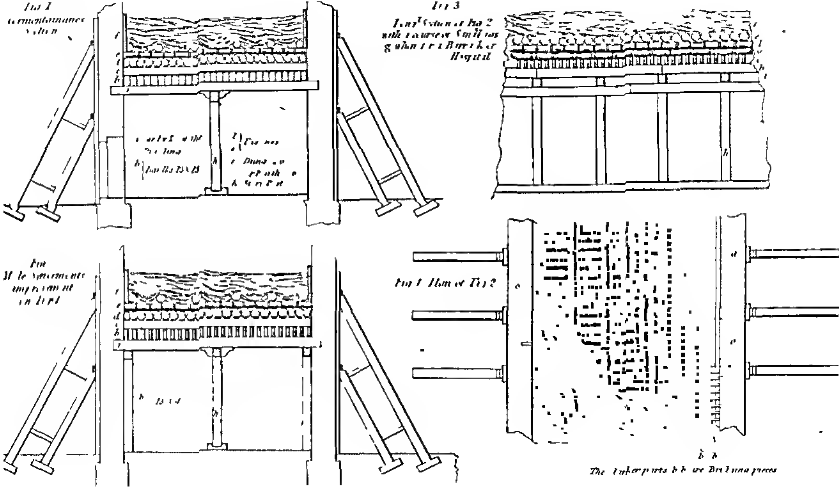
The following Table gives some little information as to what is splinter proof.

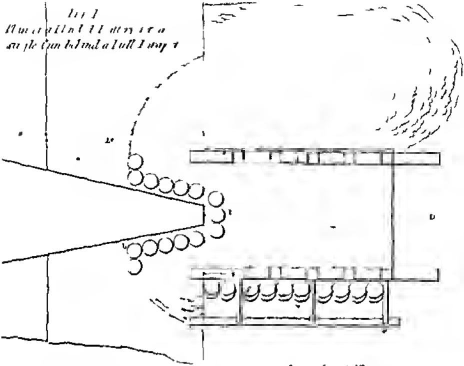
Numbers and Range of Splinters, given by French and Prussian Shells, from Experiments

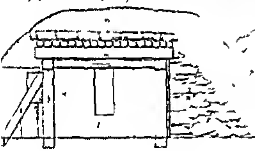
French and Prussian Denomns.	c 32	pr 50	c 27	pr 25	c 22	pr 10	c 16	pr 7	c 15	[illegible]
Approx diam in English inches	12⅔	11	10¾	8¾	8½	6½	6 1/10	5¾	5 8/10	4[illegible]
Bursting charge, lbs	8	3½	4¾	2 1/12	2 1/10	1	1	¾	½	[illegible]
Number of splinters	22	10—15	18	14—16	33	18—19	21	16—17	22	1[illegible]
Weight of greatest splinter, lbs.	..	16	..	9	..	2¼	..	2	..	..
Ditto of smallest ditto, oz .	..	10	..	13	..	5	..	2	..	..
No of splinters weighing more than 2¼ lbs	22	..	18	..	28	..	17	..	19	14
Extreme range* of splinters, yards	..	750	..	500	..	420	..	350	..	..

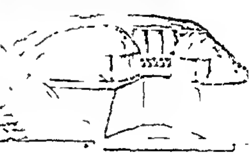
R J. N.

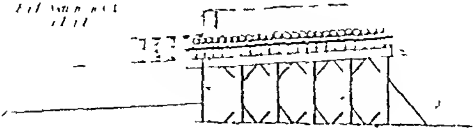
* The French splinters ranged from 650 to 900 yards In the above, 'c' is centimetre and 'pr' the peculiar mode the Germans have of denominating their mortars and howitzers, which has a very different meaning from our term of 'pounder' Their 7 pr howitzer has the same calibre as the r 24 pr gun, of which the shot weighs 24 lbs Prussian, the 7 lbs being the assumed weight of a stone ball of the same diameter. The splinters of the 10-pr and 7 pr did not penetrate a 3⅞ inch board, close to them; those of the 25 pr and 50 pr did The nature of the wood is not stated











BLOCK.*

WEIGHT OF BLOCKS, AND SIZES OF THEIR PROPER ROPES

Wood				Iron.				Metal				Size of Rope to correspond
Length of block	Single	Double	Treble	Length of block	Single	Double	Treble	Length of block	Single	Double	Treble	
inches	lbs	lbs	lbs	inches	lbs	lbs	lbs	inches	lbs	lbs	lbs	inches
26	92 00	142 00	192·00									9
24	67 00	106 00	146 00									8½
22	57 00	84 00	130 00									8
21	51 00	78 00	108 00									8
20	49 00	72 00	104 00									7½
18	35·00	56 00	78 00									6½
17	27 00	45 00	65 00									5½
15	19 00	34 00	40 00									5
14	16 00	28 00	37 00									4½
12	10 50	17 00	26 00									3½
11	8 25	13 00	18 00					9	22 00			3½
10	6 00	10 00	14 00					8	16 00			3
9	4 50	7 75	9 00	7		17 00	20 00	7	14 00	25 00		2½
7	2 25	3 75	6 00	6			16 00	6	12 00	18 00		2
6	1 72	2 75	4 50	5			11 00	5	7 00	14 00		1½
5	1 25	1 50	2 25	4		4 00		4	4 00			1½
4	·75	1 00	1 25									1

G B

BLOCKADE, MILITARY.—As a rule for Blockading a Fortress, and reducing it without a siege operation, and effectually confining the garrison within the works by a circle of fortified posts, the following narrative of the Blockade of Pampeluna is taken from Sir John Jones's 'Journals of Sieges'

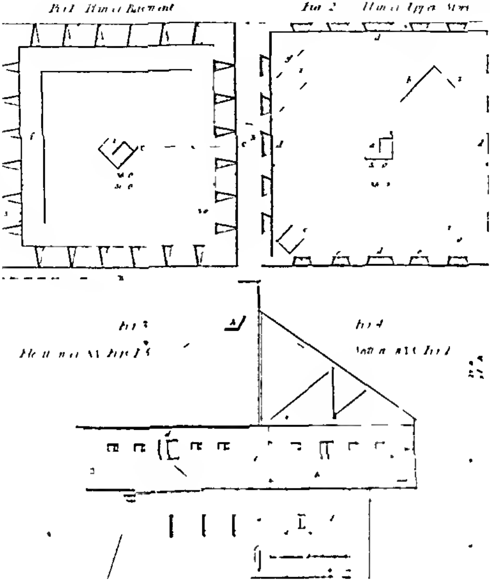
"The duties of the blockade were confided to Lord Dalhousie, with the 6th and 7th Divisions of Infantry

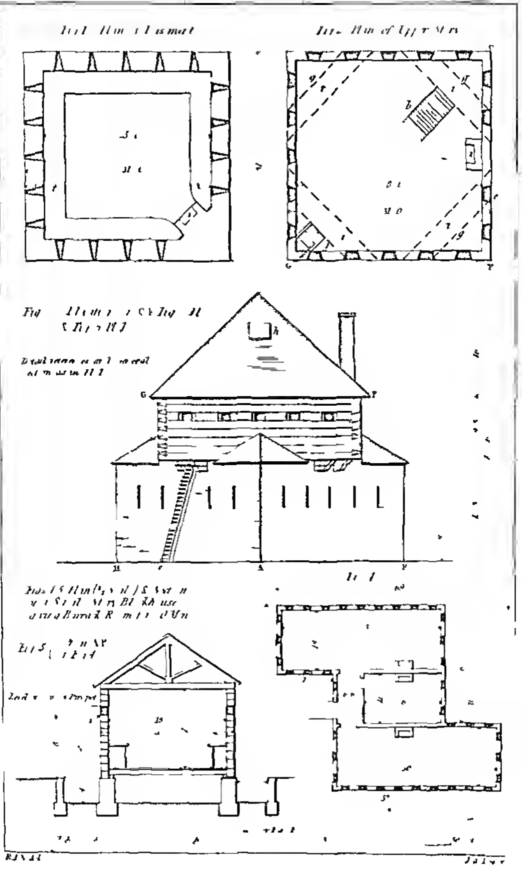
"For the more effectual confinement of the garrison of Pampeluna and to strengthen the front of the blockading corps, the Marquis of Wellington ordered works to be thrown up all round the place, on the nearest heights favourably situated to command the several roads and communications Nine redoubts, calculated for garrisons from 200 to 300 men each, were, in consequence, immediately marked out on commanding points from 1200 to 1500 yards from the fortress The redoubts were ordered to be made of a strong field profile, and to be armed with the French field guns captured at Vittoria, firing through embrasures

"The investing force furnished strong parties, which worked by regular reliefs throughout the day, but the greater portion of the labour was performed by the peasantry of the country, put into requisition for this service by the Spanish authorities

"Neither the peasantry nor the soldiers received any working pay, nevertheless, through a vigilant superintendence and the exertions of the Officers, the whole chain of redoubts was speedily in a state of defence Garrisons were allotted to the several

* As used in the Navy





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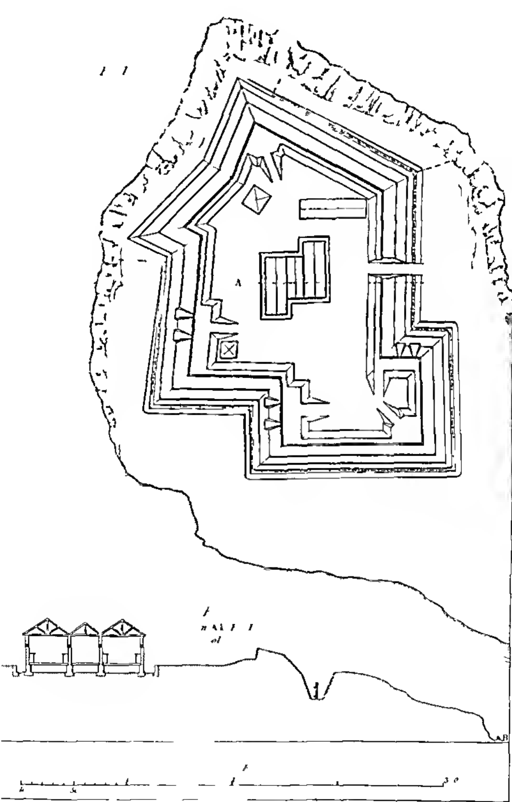

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floor will suffice for immediate defence, leaving the basement available as a barrack-room, or as a store generally

The description of Blockhouse given in Plate I, and in Plate II figs 1, 2, 3, has the great advantage, over those of the ordinary form,* of protecting its salients, and if the hinged planks, *g*, fig 2, be turned up, a respectable machicoulis is obtained.

In Plate I the upper story is pierced for 4 carronades or other light ordnance, fitted with breeching as on board ship

In Plate II figs 1, 2, 3, no artillery is supposed to be necessary, but the musketry of the upper story will fire over and extend beyond the work in figs 4, 5, the sphere is entirely limited by the works in front, to which it is the keep

Besides these, however, there are various other forms and constructions, sometimes hexagonal (as at Mondragon, near Guipuscoa, North Spain), with a sunken basement, a ground floor, and a flat roof with loopholed parapet walls, projecting as machicoulis The following are the main details of a square American Blockhouse on the Fish River, near the mouth of the Madawaska Basement and ground floor, each 25' × 25' in the clear, the former lined with masonry,—the latter, as well as the upper story, of logs, 18" square in ground floor, 12" square in upper story Height of each story 10 feet, 29 loopholes, roof hipped, with a dormer window on each side, embrasures in upper story, one on each side, stories conformable,—the upper projecting 3 feet all round, as machicoulis, beyond the ground floor, and thus 32' × 32' within

When hatches are made in the roof for the escape of smoke, they should be grated, to prevent grenades or combustibles from being thrown in, and when in an exposed situation, the roofs should be covered with zinc, sheet iron, or (as in Canada) with tin

Wind mills generally occupy prominent points of ground, and when large, and otherwise suitable, the lower part may be turned to account as the basement for a blockhouse

For the general management in building with logs, we may merely observe, that in the largest blockhouse the logs can be raised and easily placed in their exact position by a common derrick and guys —See 'Derrick'

R. J N

BOAT.—Under this head are given,—Plate I, Lines for a Ship s Launch, Plate II, Carronade Fitments for ditto, Plate III, Lines for a Four oared Gig, Plate IV, Lines for a Dingy

To avoid errors from the small scale of the Plates, the following Tables of dimensions are appended, which have been measured from authentic drawings on a large scale everything is given in inches to the nearest quarter

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* Stories conformable —upper, projecting as machicoulis all round beyond ground floor

DIMENSIONS OF BOATS

The Launch.—Plate I.

Vertical Sections	○	A	B	C	D	E	F	1	2	3	4	5	6	7	8	9	○	10*
Distances between Vertical Sections	27.75 in every instance																	
Horizontal Sections ○	61½	63½	6?½	60½	56½	42	33	61½	61	63½	61½	61½	59	56½	52	46	61½	..
Horizontal Sections a	62½	61	55½	54	46½	35	19	62½	62	61½	59½	57½	55	46	34½	18	6½	..
Horizontal Sections b	52	51	47½	41½	3?½	31½	9½	53½	53½	51½	45½	43½	36½	26½	13½	5	33	..
Oblique Sections VW	61½	..	..	..	..	..	..	..	..	63½	61½	61½	59½	56½	53	46½	..	40½
Oblique Sections VX	70	..	..	..	..	..	..	..	..	69½	67½	55½	62	38	51½	43	..	35½
Oblique Sections VY	61½	63½	63	61	56½	49	23½	..	..	..	..	..	..	..	..	..	..	..
Oblique Sections VW	72	70½	69	64	52	54	31½	..	..	..	..	..	..	..	..	..	..	..

* 10 is the stern of the boat, not a vertical section.
VA =3½
Va =31
Vb =41
Vc =56
VZ =[illegible] =WX
Zc =21

The Four-oared Gig.—Plate III.

Vertical Sections.	○	A	B	C	1	2	3	○	4*
Distances between Vertical Sections.	○ to A 29½	A to B 37	B to C 37		○ to 1 39	1 to 2 43	2 to 3 39½		
Horizontal Sections ○	33	31½	27	16	32½	29½	21½	31	..
Horizontal Sections a	31½	30½	25	12	31½	25½	10	31½	..
Horizontal Sections b	30½	27½	21	8½	28½	19½	8½	30½	..
Horizontal Sections c	25	22½	11	4½	23	12	4½	21	..
Oblique Sections VW	32½	..	..	..	33	29½	21½	..	14½
Oblique Sections VX	31½	..	..	..	31	30	21½	..	13½
Oblique Sections VY	33½	31½	27½	16	..	..	..	..	..
Oblique Sections VZ	36½	34½	27½	12½	..	..	..	..	..

* 4 is the stern of the boat, not a vertical section.
Va =16
Vb =21
Vc =27
Vd =31
VZ =11 =WX
Z1 =13

The Dingy.—Plate IV.

Vertical Sections.	○	A	B	C	1	2	3	4	5	○	6*
Distances between Vertical Sections, &c.	Between A and C [illegible] in every instance								4 to 5 [illegible]		
Horizontal Sections ○	[illegible]	[illegible]	[illegible]	31	30½	[illegible]	[illegible]	[illegible]	16½	20½	
Horizontal Sections a	[illegible]	[illegible]	33	14	[illegible]	[illegible]	25½	20	14½	22½	..
Horizontal Sections b	[illegible]	[illegible]	13½	10	25½	[illegible]	[illegible]	11½	5	[illegible]	..
Horizontal Sections c	[illegible]	14	17½	4½	[illegible]	10½	13½	6½	1½	[illegible]	..
Oblique Sections VW	[illegible]	..	..	..	..	[illegible]	[illegible]	[illegible]	[illegible]	..	19½
Oblique Sections VX	[illegible]	..	..	..	..	[illegible]	[illegible]	[illegible]	[illegible]	..	[illegible]
Oblique Sections VY	[illegible]	[illegible]	[illegible]	[illegible]	..	..	..	..	..	..	..
Oblique Sections VZ	[illegible]	[illegible]	[illegible]	[illegible]	..	..	..	..	..	..	..

* 6 is the stern of the boat, not a vertical section.
Va =[illegible]
Vb =[illegible]
Vc =[illegible]
Vd =[illegible]
VZ =[illegible] =WX
Z1 =[illegible]

DRAWING OF A LAUNCH OF 30 FEET

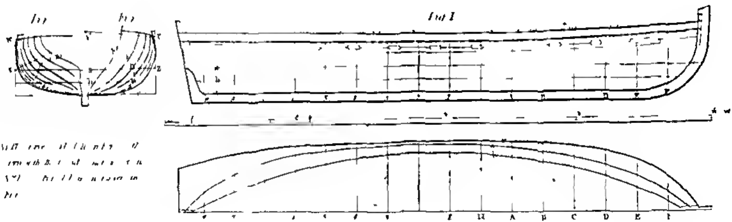
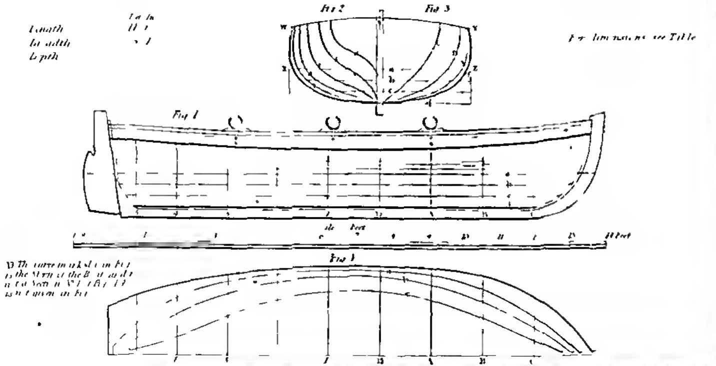


Fig 4

DRAWING OF A DINGY OF 14 FEET



Note — It has been found convenient to cut a perfect boat (conformable with Plate III) in two, athwart, dividing the length nearly into two equal parts,—for the purpose of conveying them more easily over difficult roads, or from one lake or river to another. The ends are closed by a partition to each part, and are fitted with eyes, through which a bolt or iron bar is dropped. When the two halves are thus joined, they make an excellent boat, and when separate, not a bad dingy.—*Editors*

BOMBARDMENT.*—"*It may be useful to consider the nature and efficiency* of bombarding towns, and also the proper employment and real value of mortars in the attack of fortresses.

"To bombard a town is merely to shower down upon it shells, carcasses, rockets, hot shot, and other incendiary missiles, to burn or destroy the buildings, and kill the inhabitants, leaving the fortifications untouched. In a well constructed place, the military experience few casualties under a bombardment, they, as well as the powder and store, being lodged in buildings by their construction proof against the effects of missiles, and consequently both the garrison and defences are nearly as efficient at the conclusion as at the commencement of a bombardment. Being so, it is apparent such mode of attack can never succeed, except against a very small place, where bomb-proof cover cannot be obtained, or where the Governor is a weak man, whose sense of duty yields to his feelings of humanity, or that his garrison be insufficient to keep the inhabitants in subjection, under the miseries inflicted on them. The first was the case at Bourbon, where want of shelter, and the apprehension of the principal powder magazine not being fully bomb proof, were alleged by the Governor as the causes of his capitulating. The two latter apply in their full force to Copenhagen, and at Flushing the attack was latterly prosecuted in the manner of a siege, and the Governor capitulated on account of a breach having been nearly *formed* in the face of the left bastion, so that casual circumstances alone gave effect to the bombardment at those places.

"To reduce a place by a regular siege is, in other words, to direct every effort against the fortifications, the garrison, and the armament, leaving the inhabitants and the buildings unmolested. This mode of attack is certain in its effects, but requires that the Engineers should be provided with considerable assistance, whereas bombardment is an operation of no Engineer science, and might be carried into effect by the Artillery Officers without Engineers, nearly as well as with them.

"That bombardment is not availing against a *Governor who is firm*, innumerable examples might be cited, but suffice three well known facts.

"In 1757, Frederick of Prussia bombarded the large and populous city of Prague for twenty two days, in such a furious manner that the town was nearly destroyed, and the inhabitants suffered so severely that they rose in general rebellion and attempted to force the Governor to surrender, but he remained steady to his duty, hung two of the principal Senators, and by his firmness gave opportunity for the battle of Kollin, which obliged the King to retire from before the place. In 1793, equal firmness was shewn by the Dutch Governor of Wilhamstadt, under a furious *bombardment*, and the *French*, having trusted to mortars alone to reduce the place, failed in the attempt. The third is that of Gibraltar, which was bombarded for two years previously to the attack of the junk ships, in 1782, but who ever heard General

* This article consists of detached extracts from the Notes of the work on Sieges by the late Major General Sir John T. Jones, R.E.

from the place, would naturally engross the attention of the garrison, and the mortar batteries, in their more distant situations of 1500 or 1800 yards, would probably escape observation, or at all events be considered of such minor importance as to be little molested by fire, and might be erected by the peasantry

"It is, however, to be most particularly understood, that the means of bombardment must not detract from the means for the regular attack, nor those of the latter diminish the means of bombardment There must be no mixture of the operations, each must be kept perfectly distinct.

"Far better will it prove to give the preference to either, and make it powerfully efficient, than to make two weak efforts Success from either should only be expected from its own full powers to command it

"A regular attack may, in some degree, be abridged by the skill or boldness of a Commander, but the success of a bombardment depends altogether upon its own efforts being powerful, unceasing, and maintained in their greatest fury till the proposed effect be produced

"To bombard a considerable place in a manner really efficient, at least 60 mortars or howitzers should be put in battery, and it would be better that the number were 100 They should fire without intermission throughout the day and night, and, with that view, be furnished with at least 200 rounds each per day Any increased number of mortars used at a bombardment would not necessarily increase the expenditure of ammunition, as a certain number of rounds fired in three days from 100 mortars is infinitely more likely to terrify a Governor and population into submission, than the same number of rounds fired in six days from 50 pieces"

VALUE OF MORTARS AT A SIEGE.

"As instruments to be used in furtherance of the regular attack, mortars are, however, highly useful, and in some cases indispensably necessary, particularly to search behind and knock down the defensive traverses, to drive the garrison out of their retrenchments, and carry destruction and disorder through every portion of their interior defensive expedients, to tease and harass the guards and tirailleurs, burn the barracks, storehouses, and depôts of provisions, tear up bridges, break down dams and sluices, explode expense magazines, and annihilate many earthen defences, not to be affected by shot As weapons of personal annoyance they are also of great use by their vertical fire, both great and small, for instance, in a confined advanced work, shells from a few mortars will, besides destroying the defences, cause innumerable casualties, if it be kept fully garrisoned, or, if to avoid loss, the enemy keep but few men in it, the work becomes open to assault

"A few pierriers and mortars, at the siege of Badajos in 1812, would have had such an effect on the Picurina redoubt, and heavy shells would readily have destroyed the dam of the inundation, and dislodged the defenders from the bridge Indeed, to attempt to carry on a siege without the aid of mortars, can only be compared to a man volunteering to fight a formidable antagonist with one arm tied up

"At a regular siege, as well as at every other attack, a judicious mixture of the several natures of ordnance seems to be the proper medium The proportions of each must vary according to the nature of the attack, but, when battering trains are fitted out without a precise object, it would seem advisable to have one mortar or howitzer with every four guns in large trains, and one mortar with every three guns in small trains, adding one pierrier to every three mortars It is, however, submitted to the Artillery Officers, if it would not be still better that a proportion of one pound or half pound balls should be added to their siege ammunition, in which case mortars of every diameter would be available as pierriers"

STRENGTH OF ARCHES

"The strength of masonry is far greater in southern than in northern climates,* whilst the concussion produced by the fall of shells, at equal distances, and of equal weights, must be the same in all climates and in all ages. Why, *therefore*, do arches of magazines give way more frequently now than in former wars? It can only be accounted for from the fact, that in the proportion that one shell was fired into a place in those days we, in our bombardments, throw fifty into a place. Substance is now required much beyond that essential for strength. It is not sufficient that an arch have all the requisite proportions to resist the shock of the heaviest shell, and the piers a force to bear it up, or the roof a pitch to keep it dry, it must also have bulk over it, to admit of the repeated abstractions of substance, caused by numerous shells striking it in rapid succession. Each shell blows away a portion of the covering of the arch, and if their fall be so continuous as to prevent fresh covering being laid on, they speedily penetrate to the masonry, after which each shell carries away 2 or 3 inches thickness of the brick-work, and in a few rounds the equilibrium of strength of the arch is destroyed. As soon as that is effected, a shell striking any part of the surface shakes the arch through and through, and after a time it is shaken down.†

"That a bomb proof arch should be kept extremely well covered is therefore fully as important to its resistance, as that sufficient dimensions be given to the arch itself. Officers in future must take precautions against the increased use of artillery of the present day, and no longer trust to dimensions derived from the experience of the wars of Louis XIV. *In small places, like Fort Bourbon, no magazine should have less than 8 or 10 feet of masonry and earth over its arch*, and every Governor, during a bombardment, ought most sedulously to enforce the immediate restoration of every portion of earth blown away by the fall of shells."

BOOM.—The consideration of this subject becomes important from the increased necessity of guarding against the sudden attacks of steamers, upon rivers and harbours, especially at remote points.

Booms may be applied either to bar access to a harbour or river, or to cut off the retreat of the enemy, should the entrance have been effected by surprise.

Like Abattis, Palisading, &c., before field works, Booms should never be left unprotected, and should be *immediately under fire of a battery or of a man-of war*, and its guard boats on the look-out.

It is conceived that the most effectual check to a ship's progress would be given by the partially elastic opposition of hemp cable booms, but as these are liable to be quickly destroyed‡ those of chain, floated by logs, and moored as occasion requires, seem to be most advisable, at least for the exterior line, reserving hemp, if admissible, for those in rear. It is unsafe to trust to a single line of boom in the main channel; a chance or a well-directed shot, or the impetus of the vessel in unusually strong

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* The author once had in his possession a memorandum made on the spot by an Officer, that an arch of 18 feet span and 2 feet 9 inches thick without any covering resisted two shocks of 13 inch shells successively at the siege of Fort George in N America.

† A heavy shell falling on a bomb-proof arch well covered with earth has been known to cause such a concussion as to make wine glasses jump off a dinner table in a casemate without injury to the arch.

‡ "A carpenter's mate — a hand saw and a lump of grease"—formed a standing part in arrangements for cutting out vessels in the late war when hemp cables were commoner than those of chain.

winds and tides, &c, &c, may defeat the best calculations of sufficient strength, but, with the check received from the first, if at all adequate to its duty, it would be scarcely likely for any vessel to have way enough to break a second, or at most a third, which should be placed at short distances, say from 50 to 100 yards apart in rear,—or perhaps only sufficient for two large boats to row past each other freely

Even when there is no perceptible rise and fall of tide, a boom must not be strained too tightly, as a 'passive resistance' of the dead weight of the slack portion would be lost On the other hand, if too loose, the vessel will easily pass over it

Generally speaking, the allowance necessary for the rise and fall of tide will give sufficient play. In figs 1, 2, where a length of boom of about 300 yards has been assumed, and where, as in figs 3, 4, 5, there may be a rise and fall of 18 feet in a depth of 100 feet, there will be upwards of 50 or 55 feet between the extreme positions of the boom at ebb *a*, *a*, and young flood *b*, *b*

Booms need not necessarily extend entirely across an entrance, shallow or otherwise inaccessible parts may be omitted, or else blocked up by much lighter chains than are necessary for the main channel. A trifle will keep out a gun boat,—not so a first rate or a large steamer. A boom may be kept constantly down, in whole or in part, as the urgency of the case requires Not to impede the navigation unnecessarily, the 100 yards over that part which will be deep enough for vessels entitled to enter can be withdrawn to either side entire, or to both, in halves, ready to be replaced, d_1 figs 1, 2

To give perfect facility for throwing a boom across at any moment, an express establishment will be necessary, according to the extent of the obstacle, of—

1 A party familiar with the operation
2 Housing for these, and for stores when not immediately wanted.
3 Protection for both—afloat and ashore, including guard boats
4 Moorings,—a distinct charge from the above, generally devolving on Harbour Masters

The first three will be disposed of at once, if a man of war be specially assigned to this duty, or, at all events, a hulk, not only armed, but fitted with the common arrangements of timber ships, or breakwater vessels, for readily passing out the logs, chain, &c, &c If anchored near the opening it would probably afford all the protection that could be required, as well as many facilities for general harbour duties, and the Police and Revenue Services The timber can either be rafted, moored, and left afloat, or else stowed away below This sort of provision is the least expensive, so much being left available when no longer required for this service It is best suited for the defence of small ports But, if from the importance of the harbour or river, or other causes, an establishment must be made ashore, it will probably amount to a small barrack, store sheds to receive the boom, boat house, battery and appointments complete, and perhaps a small floating dock, or a pier, should it be necessary to keep the boom afloat and in readiness

The moorings, at perhaps 100 yards laterally apart, will have nothing peculiar the buoys must be solid, as in a dark or misty night they are easily scuttled as usually built, the boom must be quite independent of these last as to buoyancy

DETAILS OF CONSTRUCTION FOR CHAIN BOOMS

It is here assumed that it is to be a continuous chain, supported by wooden floats of sufficient buoyancy to offer some resistance to the whole being readily submerged, and of such a shape as shall not expose a flat surface abruptly to the waves.

The cheapest materials will be condemned masts and the larger yards and spars of men of war, cut into suitable lengths, as short as may be convenient, and with inter-

STRENGTH OF ARCHES

"The strength of masonry is far greater in southern than in northern climates,* whilst the concussion produced by the fall of shells at equal distances, and of equal weights, must be the same in all climates and in all ages why, therefore, do arches of magazines give way more frequently now than in former wars? It can only be accounted for from the fact, that in the proportion that one shell was fired into a place in those days, we, in our bombardments, throw fifty into a place Substance is now required much beyond that essential for strength It is not sufficient that an arch have all the requisite proportions to resist the shock of the heaviest shell, and the piers a force to bear it up, or the roof a pitch to keep it dry, it must also have bulk over it, to admit of the repeated abstractions of substance, caused by numerous shells striking it in rapid succession. Each shell blows away a portion of the covering of the arch, and if their fall be so continuous as to prevent fresh covering being laid on, they speedily penetrate to the masonry, after which each shell carries away 2 or 3 inches thickness of the brick work, and in a few rounds the equilibrium of strength of the arch is destroyed As soon as that is effected, a shell striking any part of the surface shakes the arch through and through, and after a time it is shaken down †

"That a bomb proof arch should be kept extremely well covered is therefore fully as important to its resistance, as that sufficient dimensions be given to the arch itself Officers in future must take precautions against the increased use of artillery of the present day, and no longer trust to dimensions derived from the experience of the wars of Louis XIV *In small places, like Fort Bourbon, no magazine should have less than 8 or 10 feet of masonry and earth over its arch*, and every Governor, during a bombardment, ought most sedulously to enforce the immediate restoration of every portion of earth blown away by the fall of shells"

BOOM,—The consideration of this subject becomes important from the increased necessity of guarding against the sudden attacks of steamers, upon rivers and harbours, especially at remote points

Booms may be applied either to bar access to a harbour or river, or to cut off the retreat of the enemy, should the entrance have been effected by surprise

Like Abattis, Palisading, &c, before field-works, Booms should never be left unprotected, and should be immediately under fire of a battery or of a man-of war, and its guard boats on the look-out

It is conceived that the most effectual check to a ship's progress would be given by the partially elastic opposition of hemp cable booms, but as these are liable to be quickly destroyed,‡ those of chain, floated by logs, and moored as occasion requires, seem to be most advisable, at least for the exterior line, reserving hemp, if admissible, for those in rear It is unsafe to trust to a single line of boom in the main channel a chance or a well-directed shot, or the impetus of the vessel in unusually strong

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[illegible]

† A heavy shell falling on a bomb-proof arch well covered with earth has [illegible] such a concussion as to make wine glasses jump off a dinner table in a casemate without injury to the arch

‡ A carpenter's mate — a hand saw and a lump of grease — formed a standing part in arrangements for cutting out vessels in the late war when hemp cables were commoner than those of chain

winds and tides, &c., &c, may defeat the best calculations of sufficient strength; but, with the check received from the first, if at all adequate to its duty, it would be scarcely likely for any vessel to have way enough to break a second, or at most a third, which should be placed at short distances, say from 50 to 100 yards apart in rear,—or perhaps only sufficient for two large boats to row past each other freely

Even when there is no perceptible rise and fall of tide, a boom must not be strained too tightly, as a 'passive resistance' of the dead weight of the slack portion would be lost On the other hand, if too loose, the vessel will easily pass over it

Generally speaking, the allowance necessary for the rise and fall of tide will give sufficient play In figs 1, 2, where a length of boom of about 300 yards has been assumed, and where, as in figs 3, 4, 5, there may be a rise and fall of 18 feet in a depth of 100 feet, there will be upwards of 50 or 55 feet between the extreme positions of the boom at ebb *a*, *a*, and young flood *b*, *b*

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The cheapest materials will be condemned masts and the larger yards and spars of men of war, cut into suitable lengths, as short as may be convenient, and with inter-

vals not exceeding 3 feet; so that should any one piece be carried away, no very large chasm may be made by the drooping of the unsupported part. The chain should be attached to these junks of masts by very strong staples, well secured, alternating with small chain lashings; for if this be at all feebly done, it will be a weak point at which the very shock may destroy all, without a single thing being broken or disturbed, except the staples or other *fastenings being started*.—(See fig. 7.)

When a Boom is to be a permanent affair, and no old masts are to be had, it may be advisable to build solid cylindrical floats, well hooped, of the required dimensions, just as masts are constructed.

When of a temporary character, and the sacrifice of material is to be avoided, square baulks, lashed together with chain, instead of being hooped, may be substituted for the above.—(See fig. 9.)

In estimating the shock to be expected, it must be remembered that sailing vessels are not now likely to run into such a cul-de-sac as a harbour, though they may venture through a river or a strait, with open sea at both ends. Hence in the present day we must calculate as for steamers. Our largest men-of-war of this description may be taken at 1000 or 1200 tons burthen, and this, with a velocity of perhaps 12 knots, would snap any *chain cable*, as made at present, where the largest are only of 2¼-inch round iron, and unless the next such *line* be very near, it would demolish that readily, as a steamer recovers way, even if entirely stopped by the blow for the moment, in a manner that other vessels cannot do.

For such extreme cases, it is conceived that nothing less than the large and massive mooring chains, of at least 3 inch square iron, has a chance of success; and if the 2nd or 3rd lines are pretty close, even so large a vessel may be staggered, and embarrassed for a sufficient length of time to enable her machinery to be destroyed from the protecting batteries.

The selection of any intermediate sizes between such a boom, and that only sufficient to keep out boats or small steamers, must depend on the importance of the harbour or river, as well as on the draught of water determining the size of the steamer that can enter.

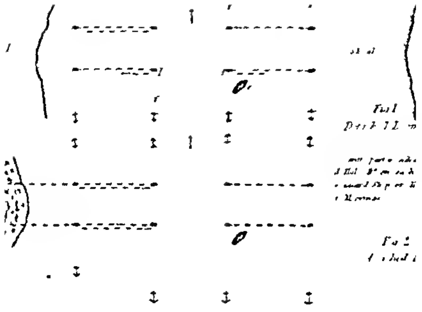
Fig. 7 shews a boom as proposed to be made out of old masts. When built expressly, the hoops and staples can be made in one (fig. 8). To support a mooring chain of 2′ 6″ links, 3″ square iron, properly, the diameter, if of yellow pine, ought not to be less than 30 inches.

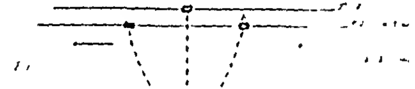
If the square form be decided on, a side of 32 inches will be required (fig. 9), the lower baulk alone need have staples or clamps. The chain used as lashing will do no injury to the wood, and any degree of tightness and compactness can be given by means of wedges.

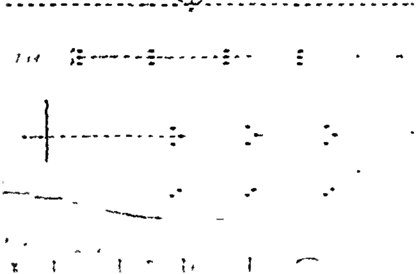
Fig. 10 is a baulk siding, 18 inches, as necessary for the largest class *chain cable* made at present.

Booms for small rivers, to protect pontoon bridges, &c., or to obstruct navigation, are easily made on the above principles, except that, should the vessels on the river be of light draught only, and no serious attack be apprehended, logs of wood, connected by short chains, and couplings well let in and secured will probably be sufficient. Whether the boom is to go directly across the stream, or to do so obliquely, so as to reduce the strain, will be determined by localities and the strength of the materials available.

A line of palisading is sometimes used to close a river. It is rarely advisable, and very expensive, especially if only for temporary purposes, for if it be mere palisading in bays, hanging on ribands, it can be easily cut through in the night; but if the main posts or piles be at all near enough to prevent boats from passing, they will, in







most cases, and in no great length of time, by accumulating mud sand, &c., form impediments to navigation not readily removable

HEMP CABLE BOOMS

The buoys, moorings, and general arrangements remaining as before, the slight assistance necessary to support the cable will be best given by spars of moderate scantling, which add to the strength in a way that is not done by casks or small buoys When from necessity casks—always liable to damage—are used, care must be taken not to expose their ends to the sea, or they will soon be destroyed

R. J N

BREACH, as effected by Artillery —No precise rule can be given either as to the time or ammunition required to make a Breach The best precedents within reach are therefore given, leaving their application to circumstances

The two most recent and complete examples are those given by the French experiments at Metz, 1834, and in their siege of Antwerp in 1832 They differ considerably, chiefly, perhaps from the latter having been conducted under fire and the former, (like our experiments against Carnot's Wall) at leisure and undisturbed, especially as they were made against a fine specimen of Vauban's masonry, which could scarcely have been surpassed by anything at Antwerp

	Guns	Width of Breach feet	Shot and Shell	Distance yards	Total Time hours
Antwerp	6 24 prs	80	1288	5[illegible]	31
Metz	4 24 prs	72	2[illegible]6*	35	8†
	4 16 prs	75	32[illegible]*	33	9¼†

The best representation of the variable effects of Breaching Batteries is given by Capt Sir Wm Denison, in vol ii p 38, Corps Papers

	Width of Breach feet	No shot	Distance yards	
1812 —Christoval	15	1 600	4[illegible]0	
Badajos main breach	180	14 000	510	
,, flank ditto	100	9 500	530	Wall casemated
,, curtain ditto	40	3 000	545	Bad masonry
Ciudad Rodrigo, main ditto	105	6 700	560	
,, lesser ditto	30	2 090	570	Bad masonry
1813 —St Sebastian				
main breach	100	13 000	620‡	Good masonry
lesser ditto	30	5 000	620‡	Ditto
addition to breaches	330	41 000	520‡	Ditto.
	930	95 890	4955	

* Including forty 8-inch shells to each breach

† Total time including that probably required for exchanging guns for howitzers

‡ Average distances The quality of the masonry from a R. E Officer engaged in the siege

Security from destruction by the enemy.	From *peculiarity of* construction *in detail, or from its* general arrangement.
Ultimate buoyancy.	
Stability.	
Height of superstructure above water.	*As illustrated below,* with regard to the most probable elementary forms proposed for buoyant bodies*
Ease of management and motion on water	*Implying also lightness, and suitability for speed in rowing as a raft, boat, &c.; capability of movement as a quadrant of conversion*
Facility of detail, construction, and repair.	*As requiring only such material and workmanship as may most likely to be at hand.*
Security from destruction by natural causes.	*Strength to oppose the violent action of wind or water, little liability to split or warp from heat or ice; or to spoil in store, or in use, by the general action of heat, moisture, or by vermin, &c.*
Cost and current expenses.	

BRIDGE, PONTOON;† RAFTS, GENERAL EQUIPMENT, &c.

Pontoons are *hollow cylindrical vessels of tin, which, being perfectly water tight,* possess *from their shape great buoyancy, and are used for forming bridges for the* passage of *rivers by armies in the field.*—See Plates I. to VI

A pontoon consists of a cylinder 19 feet 6 inches in *length by 2 feet 8 inches* in diameter, with parabolic ends, each 2 feet 6 inches long; the total length *of a pon*toon is consequently 24 *feet* 6 inches.

Pontoons are usually *formed* of sheet *tin, of the description and quality known in the trade as × × ×, framed round a series of light wheels* constructed of tin, having hollow *tubes of 1 inch diameter for the spokes;* the axis, a hollow tin cylinder $1\frac{3}{4}$ inch diameter, running *through the entire length of the pontoon.*

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* The following Table gives nearly the relative heights remaining above water of the Square, the Circle, and *Equil Triangle of equal areas on submersion to ½ ⅔ ¾ of their buoyancies, the two last figures giving (with reference to probable forms) the extremes of greatest and least area in relation to periphery*

	A	B	C	D
	Square	Circle	Equil Triangle on its base	*Equil Triangle* on its vertex
Buoyancy reduced to ½	50	47	93	39
,, ⅔	33	42	76	24
,, ¾	25	34	66	18

Hence, could stability be given to C, it would *in this respect be the best, then B; then A, and D, the worst*

† *Royal Engineer Establishment, Chatham, 25th June, 1832*

It having become necessary to reprint the Pontoon Exercise, some trifling alterations will be found which are more in form than in details

As it is very desirable to simplify the drill as much as possible the detachments attached to the carriages have been regulated in such a manner, that when the pontoons and stores are unpacked ready for forming a bridge, the same detachment should form the crew of the raft carried on the *carriage to which they had been originally told off*

The exercise is divided into two parts, ' Packing and unpacking the Carriages,' and '*Forming a* Bridge' which can thus be practised separately

Those Officers who have had experience in marching with a pontoon train are well aware of the *great importance of having every thing on a carriage properly and securely packed in order that no*

The pontoon is internally divided into nine distinct compartments, perfectly water-tight and independent of each other. It is provided with four rows of sunken handles, placed at intervals of 2′ 1″ round the circumference, for the purpose of lashing the saddles which are placed on it, and form the bearing of the baulks which support the superstructure of the bridge; each end has a stout iron ring securely attached to it

SINGLE RAFT.—*Two pontoons*, with their allotted superstructure and stores, form a single raft.

DOUBLE RAFT.—*Two single rafts*, connected together, form a double raft, on which heavy artillery can be conveyed across a river

PONTOON BRIDGES are formed by the connection of rafts in sufficient number to reach across rivers of moderate width, and are connected with the banks by means of temporary stages or landing-places.

A PONTOON BRIDGE, so formed, is capable (under several modifications of structure) of sustaining the passage of heavy artillery and stores, and troops of all arms of the Service.

THE SADDLE of a pontoon is a framing of fir, 12 feet in length, 1 foot 2 inches in breadth, and 3 inches in depth, which is placed lengthwise on the centre of the pontoon, and secured to it by lashings, to receive the ends of the baulks extending from pontoon to pontoon.

BAULKS are likewise of fir timber, 14′ 2″ in length, 4½″ in depth, and 3″ in breadth, placed in position from saddle to saddle, and being secured to them by means of iron pins or bolts, form the supports of the flooring of the bridge or raft

WHOLE CHESSES, which form the floor of the bridge, consist of three fir planks, connected together by four cleats on the under side, and are 11′ 5″ in length, 2′ 1″ in breadth, and 1½″ in depth.

HALF CHESSES consist of a single plank 11′ 5″ in length, 1′ 0½″ in breadth, and 1½″ in depth, strengthened by cleats in a similar manner to the whole chesses, and are placed over the saddles in order to afford ready access to the pins, &c.

Each raft is furnished with 2 saddles, 12 baulks, 10 whole chesses, 4 half chesses, 1 anchor and cable, 6 oars for rowing and 1 oar for steering, 1 buoy line and 1 breast line, 1 boat-hook, and a proportionate number of lashings.

A PONTOON CARRIAGE is a four wheeled carriage with a perch, and bolsters over the axle-trees, and is capable of carrying a raft and its stores

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interruption to the march and consequent delay to a whole column may arise from the necessity of making a halt to repack any of the stores which may have become deranged by the motion of the carriage

To the proper packing of a carriage the greatest attention therefore is required from the Officers and Non Commissioned Officers attached to a pontoon train, who ought personally to inspect the several lashings of each carriage every morning before moving in order to ascertain that everything is secure and in its proper place inattention to these particulars may occasion great delay and retard the movements of columns of troops which may be moving on the same line of road, but in rear of the pontoon train and the pontoons may fail to reach the spot where a bridge is to be formed at the appointed time

The word 'Port' having been adopted in the Royal Navy instead of the word 'Larboard' the same rule is now observed in the Pontoon Exercise, and the word 'Larboard' will be found omitted.

HARRY D JONES,
Colonel, Royal Engineers Director

Table of Stores carried on a Pontoon Carriage

	No.	Dimensions						Weight		
		Length		Breadth		Depth		cwt.	qrs.	lbs.
		ft.	in.	ft.	in.	ft.	in.			
Pontoons	2	21	6	2	8	2	8	10	0	10
Baulks . . .	12	14	2	0	4½	0	5	5	1	22
Chesses	10	11	5	2	1	0	1½	8	2	14
Half Chesses . .	4	11	5	1	0½	0	1½	1	1	16
Saddles	2	12	0	1	2	0	3	1	1	27
		Shank		Flukes		to F claw				
Anchor	1	3	10	2	0	0	1	..	1	27
Buoy	1	2	0	0	10	0	10	..	..	5½
Cable, 32 fathom .	1	[illegible]	0	0	3	Rope		..	2	7
Oars	7	14	0	..		..		..	3	26½
Boathook . . .	1	16	0	..		..		..	..	9
Body Lashings . .	3	8	9	0	4	Webbing		..	..	20
Saddle Lashings .	4	15	0	0	1	Rope		..	..	5
Carriage Lashings .	4	22	0	0	1	Rope		..	..	7
*Rack Lashings .	8	6	0	0	2	Rope		..	..	5
*Rack Sticks . .	8	1	0	0	1½	0	1½	..	..	5
*Buoy Line	1	60	0	0	1	Rope		..	..	5
*Breast Line	2	60	0	0	1	Rope		..	..	10
*Outriggers . .	2	11	5	0	4½	0	3	..	2	20
Carriage Weights .	..	..		..		..		13	3	20
Total Weight . .								41	1	11

The baulks are the first stores packed; these are placed on the centre of the bolsters, which are cut to receive them, so that when laid in their proper places the tops of the baulks and the bolsters are level; the chesses are placed immediately over them, the two saddles are laid over the chesses, and the cable stowed between the saddles; the two pontoons are then placed on the saddles, the oars being packed over the cable between the under side of the pontoons; the anchor and buoy are securely lashed to the perch of the carriage.

The pontoons and stores are secured to the carriage by webbed girths which are passed over the pontoons and lashed down to the carriage.

DETACHMENTS FOR PONTOON CARRIAGES.

The men belonging to the pontoon train are told off in detachments of 6 men, (with a Non Commissioned Officer where one can be spared) and each detachment of 6 has charge of a carriage with its pontoon and stores.

The Officers are distributed by the Commanding Officer according to their number amongst the different carriages.

The carriages are numbered from right to left.

The stores being laid out on the ground, and the men drawn up in line in rear of the carriages, *the following Instructions detail the mode to be adopted.*

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* These are packed in the carriage-box not being used until the bridge is formed

TO PACK THE CARRIAGE.

WORDS OF COMMAND	
Numbers by Threes from the Right	The front rank men are the left section, and the rear rank the right section
Threes, Left Wheel, Quick March Halt Dress	
Non Commissioned Officers number Detachments from front to rear.	The men will then be proved, until each Non Commissioned Officer and private knows his number, and how they are told off.
Form up on your respective Carriages, Right face, quick march	The detachment will be marched right in front along the rear, and will be halted in succession behind their respective carriages

No 1, Right Section, halts in line with the off fore wheel.
„ 2, „ „ covers him between the wheels
„ 3, „ „ do 1 and 2, in line with the off hind wheel.
„ 1, Left Section, halts in line with the near fore-wheel.
„ 2, „ „ covers him between the wheels
„ 3, „ „ do 1 and 2, in line with the near hind wheel

Prepare to pack the Carriages

Collect Stores

The Right Section lays out . . .

1 Pontoon
1 Saddle
5 Chesses
2 Half Chesses
6 Baolks
4 Oars
2 Outriggers
1 Cable
1 Anchor
1 Buoy

To the right side of the carriage.

and

The Left Section lays out . . . .

1 Pontoon
1 Saddle
5 Chesses
2 Half Chesses
6 Baulks
3 Oars
1 *Boat hook*

To the left side of the carriage.

They will also collect the following small stores and lashings and place them in the box, in the front of the carriage viz.

3 Body Lashings
8 Rack Lashings and Sticks
4 Pins
1 Breast Line
1 Buoy Line
4 Saddle Lashings
4 Carriage Lashings.

The greatest care possible must be taken by the Non Commissioned Officer in charge that the above small stores have been duly collected and placed in the box, in the dark, men are in the habit of placing them on the ground where they are liable to be lost The Detachment will then fall in at their respective places on each side of the carriage

Pack the Carriage

Baulks — At the word 'Baulks' No 1 right section will place himself at the front and 3 left section at the rear of the carriage, ready to pack the stores, which the other four men from their respective sides of the carriage will hand to them

Four baulks are placed flat on the bolsters of the carriage, the other eight baulks are placed edgeways on the former, and are bolted and keyed to the fore bolster

Chesses — At the word 'Chesses,' No 1 right and No 3 left section pack them, the other four men lift them on the carriage

Care must be taken that the first chesses are laid ledges uppermost, and flush with the front end of the baulks The next chess is laid ledges downwards, and retired sufficiently for the ledges to be clear of each other, and so on alternately

Saddles — At the word 'Saddles,' the left detachment bring up one saddle and the right detachment the other, placing the cleats downwards, the pins outwards and within one inch of the outer edges of the chesses

Lash down Saddles — Nos 1 lash the saddles to the fore bolster, and Nos 3 to the hind bolster of the carriage, the lashings are made fast to the inner rings on the bolsters in front of the fore bolster, and a turn taken round the outside horn of the belaying cleats of the saddle, they are then passed through the ring and up through the hand holes of the chesses, round the inner horn of the belaying cleats, and again down through the hand holes of the chesses at the rear of the carriage, but outside of them in the front, then again through the rings and are fastened by a frapping turn. Whilst Nos. 1 and 3 are thus employed, Nos 2 lash the anchor and buoy to the perch of the carriage

Outriggers and Cables — At the word 'Outriggers and Cables,' No. 1 right an[illegible] these stores from Nos 2 and 3 right [illegible] up the cable [illegible] the Stores

Prepare to place Pontoon on Carriage — Upon this [illegible] of the detachment place themselves at equal distances on the outside of the pontoon to be placed first on the carriage Two baulks are then withdrawn from the carriage for the purpose of rolling up the pontoon on to it one end of each baulk resting on the superstructure which has been packed and the other end resting upon the ground at an angle convenient for rolling the pontoon on to the carriage

Roll Pontoon on Carriage — The pontoon is then carefully rolled up the baulks on to the saddles and the baulks replaced on the carriage

Lash down Pontoons — Nos. 1 will lash the head and Nos 3 the stern of the pontoons by the handles of the pontoons to the saddles round the back of the belaying cleats, No. 2 left will assist at the head and No 2 right at the stern; after which Nos 1 and 2 will pass the oars and boat hook between the pontoons with the blade to the rear and Nos 3 will lash

three oars and the boat-hook to one of the inner handles at the stern of the pontoon, and three oars to the other, great care being taken to secure the oars, to prevent them slipping off the carriage in travelling

Pass the Body Lashings over the Pontoons No 2 left gets on the top of the pontoons to adjust the fenders attached to the lashings, Nos 1 and 3 pass the front and rear and 2 right the centre body lashing over the pontoons, and as soon as the fenders are adjusted No 2 left goes to his place at the side of the carriage

Make fast the Body Lashings Nos 1 and 3 lash their respective ends of the body lashings to the two outer rings at the side of each end of the bolster of the carriage, and Nos 2 passing the respective ends of the centre lashing through the centre handles of the pontoons, cross the ends to each other under the baulks, and then through the triangular rings at the opposite side the whole of the body lashings are made fast by a frapping turn

TO UNPACK THE CARRIAGE

Unlash and cast off the Body Lashings Nos 1, Nos 2 and Nos 3 unlash and cast off their respective ends of the body lashings Nos 3 then unlash the oars from the inner stern handles of the pontoons No 2 left gets on the top of the pontoons and disengages the fenders

The left section then fold up the body lashings and place them in the box at the front of the carriage They also withdraw the oars and boat hook from between the pontoons, and place them on the left side of the carriage

Unlash the Pontoon Lashings Nos 1 and 3 unlash the lashings at their respective sides and ends of the pontoons, No 2 left section assisting at the head and No 2 right section at the stern The pontoons are then rolled steadily down on two baulks placed as in packing them

Unlash and dismount the Saddles Nos 1 unlash the fore lashings and Nos 3 the head lashings of the saddles and dismount them placing them alongside their respective pontoons, Nos 2 at the same time unlash the anchor and buoy, and place them on the right side of the carriage

Dismount the Stores No 1 right places himself at the front and No 3 left at the rear of the carriage ready to hand the stores to the right and left Nos in the following order

The cable and 2 outriggers to the right Nos

5 chesses, 2 half chesses and 6 baulks respectively to the right and left Nos, who will place those stores on the ground on their own side of the carriage, the Non Commissioned Officers observing that they are neatly packed

FORMING THE BRIDGE

In forming the bridge the detachment of each carriage form the crew of a raft, whose number corresponds with the number of the carriage. No 1 carriage becomes No 1 raft, and so on

The stores being unpacked and placed by the side of the river, the bridge is now formed by launching successive pontoons into the river and placing the superstructure on them, this is termed—

BOOMING OUT

The pontoons should not be rolled down but carefully carried to the edge of the water below the position where it is intended to form the bridge, and they will be brought up to their places against the current.

THE DUTIES OF RAFT DETACHMENTS

RAFT No 1.—Nos 1, *cable men*, who will keep the bridge in its proper position, and belay the cables to the rafts by the belaying cleats of the saddles of the pontoons opposite to the anchors, shifting them as the bridge is boomed out, and taking great care that they do not cross the cables

*NOS 2, SMALL STORE MEN, who take in four oars and one outrigger, on the starboard side of the bridge, and three oars, a boat hook, and another outrigger, on the port side of the bridge, which stores are handed to them by Nos 3 of No 7 raft The whole of these stores are laid across the pontoons.

NOS 3 LAY THE CHESSES, taking care that the joint of the two half chesses are over the centre of the saddles, and flush with the belaying cleats

RAFT No. 2 —Nos 1 will lash the saddles on the pontoons, which must be over the centre and within three inches of the second handles from the ends of the pontoons, this lashing must pass three turns over the saddle and twice in front close to the ends of the saddle, and be made fast by a couple of half hitches.

NOS 2 WILL PASS THE PONTOONS, under the saddles, and Nos. 3 will haul them up to be in readiness

RAFT No 3 —FRONT SADDLE MEN —Nos 1 and Nos. 2 will pass and pack the chesses on the pontoon last inserted, Nos. 3 pin the baulks to the second saddle from the land, assisted by the baulk men

RAFT No 4 —BAULK MEN.—No 1 starboard brings up the right baulk, No 2 next baulk, No 3 right centre baulk, No 1 port the left baulk, No 2 the next, No 3 the left centre baulk, and the whole will assist in pinning the baulks to the saddles, taking care to pin the two outside baulks to the saddles before any more are placed

RAFTS Nos 5 and 6 —CHESS MEN —Nos 1 of No 5 raft will bring up two half chesses and lay them across the baulks joining the shore bay,—Nos. 2 the first whole chess, Nos 3 the second, Nos. 1 of No 6 raft the third, Nos 2 the fourth, and Nos 3 the fifth, which must be brought in succession and be laid in a similar manner to the two half chesses, with the wide space between the cleats towards the river The chesses must be laid gently on the baulks.

RAFT No 7.—Nos 1 and 2 SADDLE MEN —Nos 1 will bring up the front saddle and will lay it parallel to the river, with the pins towards the land, Nos. 2 will place the second saddle at about 12 feet distance, and in rear of the former and parallel to it, with the pins towards the river and so on alternately These men will assist in pinning the baulks to the rear saddle

NOS 3 BRING UP THE OARS, boat hook and outriggers and hand them to Nos. 2 of No 1 raft, taking care to hand four oars and one outrigger to the starboard side and the remainder of the stores to the port side of the bridge

Prepare to boom out — No 3 raft will man the front saddle No 4 raft the centre saddle, and No 7 raft the rear saddle Nos. 1 and 2 of each raft will man the ends of their respective saddles

No 3 the centre between the two outside baulks the port on the port side, and the starboard on the starboard side of the bridge

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* When boots can be obtained, they should be put on by the whole of the men of No 2 raft, and Nos 1 and 2 of No 3 raft

Prepare to lift The whole of the crews of rafts Nos 3, 4, and 7 will stoop down and lay hold of the saddle and baulks, and at the word '*Lift*' the whole of the superstructure will be raised up

Boom out The bridge is pushed gently out, until the pontoon to be inserted is in its proper position under the saddle.

Down The superstructure is laid gently on the ground, and the requisite stores required for another bay brought up, and so on until the length of bridge is completed

After the bridge is completed, the men on the bridge go ashore and fall in by rafts, in a line with and near the head of the bridge, the Non Commissioned Officers of each raft having previously supplied themselves with eight rack sticks and lashings, two breast lines and two grummets, to make fast the steering oar

Form by threes on your respective Rafts The whole move off together, and when arrived on the bridge are not to be allowed to keep the step as in military movements,—Nos 1 and Nos 3 halting on their respective rafts over the pontoons, and Nos 2 in the centre of the rafts the Non Commissioned Officers in the centre of the bay on the lower side of the bridge

The Non Commissioned Officers should immediately make fast their breast lines on the stream side of their own raft to that of the raft nearest the shore The rack sticks and lashings should be reeved through the handles of the pontoons, those for the starboard * side of the bridge to the starboard pontoon, and those for the port side of the bridge to the port pontoon

Rack down At this word each man will provide himself with a rack stick and lashing and each Non Commissioned Officer with two, Nos 1 and Nos 3 place the oars and outriggers in their proper positions, and Nos 2 hand them the rack sticks and lashings; Nos 1 and 3 will rack down over the pontoons Nos 2 over the centre of the rafts, and the Non Commissioned Officers over the centre of the bays The outriggers are placed over the centre of the pontoons, the middle row-lock being over the belaying cleat of the saddle

The oars are placed two blades being towards the head of the bridge and two towards the shore, the looms of the oars resting on each other, to bring them as close together as possible, the lap of the oars and outriggers will then be in the centre of the raft and bay, and they will be firmly secured by a rack stick and lashing

This is a most important operation, and adds greatly to the strength of the bridge, it should be frequently practised by the men before the bridge is broken up The Non Commissioned Officers should at all times make themselves perfectly satisfied *that the whole of the rack sticks and lashings are properly secured*

When the baulks are laid at close order for the passage of heavy artillery, the bridge is strengthened by passing one of the side pieces under the ends between the two first holes in the baulks, and they are lashed with the carriage lashings by reeving them through the holes of the baulks and then making fast by frapping turns round the whole, drawing the lashings close up to the side pieces between the baulks.

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* In speaking of the starboard or port side of the bridge it is supposed that the river is to the front when standing on the shore from which the bridge was formed

TO DISMANTLE THE BRIDGE

Prepare to dismantle In dismantling the bridge, the same distribution of the men holds good, each man undoing what was previously done by him at the formation of the bridge

Dismantle The chesses connecting the bridge with the shore are to be first taken off, and the bridge is then to be drawn towards the land by the baulks, till the first pontoon comes to the bank of the river, its saddle is then unlashed, and the pontoon is withdrawn by the proper numbers detailed in the formation of the bridge, viz Nos 2 of No 3 raft In like manner two more sets of chesses, and two more pontoons, are to be withdrawn from the saddles so that three saddles, with their baulks pinned to them, are on shore The baulks of the first raft are then unpinned and removed, and the bridge being drawn further in, the same process is repeated until entirely dismantled

BRIDGE, BOAT.*—Plate VIII

Small craft should be collected from up and down the stream, as well as from tributaries to the river, and when a bridge of this sort is contemplated in the presence of an enemy, a rapid and well disguised movement should be made to collect the boats

Such vessels as are built for cargo are best adapted to this purpose,—neglecting the slighter kinds of boats used for passengers only, except the few that may be necessary during the construction of the bridge

As soon as they are assorted to each side of the river, the inequalities of size, and the irregularities that would be thereby produced in the bridge floor, must be made good by trestles (figs 1, 2 Plate VIII) along the centres of the boats the baulks must lie on these trestles, and never on the gunwales of the boats, which would certainly be crippled.

Allowance must be made for the degree of pitching and rolling to which the boats may be subject —in the distances between them —and in the manner and extent to which the baulks are to overlap one another at the ends On the Adour Bridge this motion was occasionally so great as to render it then fit only for Infantry Whether the boats are to be anchored stem and stern throughout, or partially so, will depend on liability to turn of tide backwater, floods &c.

Bridges should, in general be on straight lines across the river, the idea of their receiving strength from an arched form is fallacious, as no general lateral abutment takes place, each part being mainly dependent on its own moorings in tide rivers, likewise, this arrangement would be reversed every tide

The sizes of the boats cannot well be specified, the most suitable must be taken that can be had, but, generally, they should be such that when the bridge is completed, and under its extreme burthen the boats gunwales should be at least 1 foot above the water

Mem^{m} —The Bridge over the Indus by Capt G Thomson, H E I C Engineers is recommended as an *excellent* study in Boat Bridges —See Professional Papers vol iv p 92

* Abridged and modified from Sir H Douglas

BRIDGE, ROPE.—Plate IX.

Rope Bridges of a complicated description are not given, being unfit for military purposes, and especially objectionable on the grounds of economy, and liability to destruction.*

Those that are suited to temporary and military purposes are extremely simple: that made by Colonel Sturgeon, over the broken arch at Alcantara, in 1810, is given, chiefly from a drawing by the Staff Corps. This Rope Bridge spanned 100 feet; it was removed and replaced with ease, and was readily packed for transport. It was adopted from the impossibility of procuring proper timber to restore the communication.

Colonel Sturgeon's Bridge is constructed thus:—Three hawsers, A, are strained between 2 beams, B; over this, by means of the blocks and tackles, C, is drawn the net-work, D (stretched between the 2 beams, E), which supports the cross beams F, bearing the joists, G, and the planking, H. The whole is steadied by the guys, I.† The net work outside the planking is covered by a stripe of tarpaulin, J, to prevent horses, &c., from being frightened, and a light side fence of rope, K, supplies the place of a hand rail.

A and B are hauled tight by capstans to the 5 tackles, C, at each end; A and B are laid in grooves cut in the road way; B also passes through the parapet wall on both sides, if for the restoration of a bridge; or is knotted behind piles, or trees growing on the banks, if for an independent bridge. D and E are strained in like manner. D consists of one rope, passed 19 turns round E, within the breadth of 18 feet; the 10-feet lengths for F are marked off, and well tarred at the places where F are to be; these 10 feet lengths are subdivided into 3 parts to mark the meshes, which are gathered in and seized with spun yarn. F are notched at 1-foot intervals, so as to fit down on the net work, to which they are lashed by a running lashing of Hambro' line. G in 10 rows; these are rounded off, and strapped with iron at the ends; the holes e, e, e, fig. 3, admit of adjustment in the wood work when any change of length takes place in the rope work, from contraction by wet, or extension from the weight supported. The planking, H, is looped together by spun yarn at b, b, fig. 1.

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* As an extreme case, however, a sketch of a *Field Suspension Bridge*, somewhat on Dredge's principle, is given, fig. 9, Plate XIV. The strong cables that are necessary where all the weight rests on two or three main ropes are not always to be had: in the present instance, where the burden is divided among many suspenders, far smaller and more generally obtainable materials will suffice. In the sketch, the point a is obtained by a sufficient number of jumpers sunk into the face of the rock; the ends of the ropes being secured in like manner where no trees, &c. &c., are to be had. Should no such local resources for fixing a and b present themselves, strong trees or masts must be substituted. This sort of bridge must be well stayed by guys.

† Guys should be shewn in the Plate; they lead from the centre of the bridge, on both sides, to the banks above and below.

Table of Materials and Transport necessary for a Bridge as above described

Reference to Plate	Stores	No	Dimensions: Length	Dimensions: Breadth	Dimensions: Depth	Weight: Detail	Weight: Gross	Loads of a 4 wheeled Waggon
	TIMBER.		ft in	ft in	ft in	lbs (At 40 lbs per cube foot)	cwt	
B	End ties	6*	15 0	1 0	1 0	3600		2
E	Main beams . .	2	22 0	1 0	1 0	1760		1
F	Cross ditto . . .	11	20 0	0 6	0 8	2960		2
G	Joists single . . .	50	11 4	0 2	0 6	1920		1
G	Ditto, double . .	100	11 4	0 1½	0 6	2810		2
H	Planking, 9 inches wide	187	12 0	0 9	0 1½	8140		6
			Total timber . .			21520	193	
	ROPE-WORK, &c					(Calculated on weights as given in Table.)		
A	Hawsers	3	170 0	9 inch		1581		1
C	Tackles	10	96 0	4½ inch.		749		1
C	Lashings to blocks, &c.	40	30 0			935		
D	Net work . . .	1	2000 0	3-inch.		700		
I	Guys	4	200 0			280		1
K	Side fences	2	400 0	1½ inch		72		
	Lashings to F .	11	50 0	Hambro' line		50		
J	Tarpaulins . . .	2	100 0	3 0	"	448		
	Spun yarn . .	4	cwt	"	"	448		1
	Treble blocks . . .	20	1 3	"	"	600		
	Double ditto . . .	8	0 9	"	"	62		
			Total rope, &c. .			6126	55	
			Total weight of bridge .			27646	248	18

BRIDGE, BOAT AND ROPE.—Plate VIII

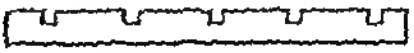
The Bridge over the Adour, designed by Colonel Sturgeon, of the Staff Corps, and executed by the Royal Engineers, is the finest example on record of this kind of communication

The arrangement of the tension gear is much the same as that used at Alcantara.

The Plate and Description are from Sir H Douglas, and Sir J T Jones, R E

"Forty-eight chasse marees were taken up in the ports of St Jean de Luz, Socoa, and Passages, collected at Socoa, and each loaded with

48 3 inch planks 9″ × 12′.

1 Sleeper, 10″ × 10′, notched thus 

2 Hand saws

2 Axes

2 Skeins Hambro' line, to lash the planks to the outside cables Two men of the

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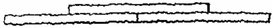
* In mountainous countries it will rarely be practicable to carry beams long enough to go through both parapet walls of such a bridge, nor is it always easy to obtain them Three pieces have therefore been allowed for each end tie to be made into one beam thus—by lashing them together provision is made in C, above for these lashings



Corps of Royal Sappers and Miners were put on board each vessel to level the waist-boards with the decks, so that the cables might be stretched across as soon as the vessels should be moored. The floor was supported by five cables, lashed in the notches of a sleeper placed fore and aft, on the deck of each vessel. Five cables, 13 inches in circumference each, and 120 fathoms long, were put on board the chasse-marées destined for the centre of the bridge, and so coiled that they could be handed up the hatchways, right and left, at the same time.

"The river was bounded on both sides by perpendicular stone walls, 14 feet high, and the same thickness. That on the left bank was backed behind by sand, level to its surface; while the ground behind the wall on the right bank was 12 feet lower than the top of the masonry, and covered at high tide by 7 feet water. The rise of the tide, at springs, was 14 feet.

"On the right bank, the end of each cable was fastened to an iron 18 pounder, which was thrown over the wall. Those parts of the cables which rested on the masonry were served with green bullock hides, to prevent rubbing. On the left bank, they were stretched by capstans and gyn tackles, fixed to a frame of timber laid on the sand behind the wall, 3 feet lower than the top of the masonry, (Bridge, Plate VIII. figs. 5, 6) and loaded, in the rear, with sand bags, to prevent it from tilting upwards.

"The chief disadvantage in substituting cables for beams is, that the navigation of the river cannot be opened by removing one or two boats, with their proportion of floor; for the cables being stretched by capstans from bank to bank, and only borne by the boats, cannot be secured but by spanning the whole river. Cables are, moreover, expensive, and with every precaution very soon chafe. Hence the application, excellent as a temporary expedient, should be replaced by beams as soon as they can be procured; when care must be taken to apply them so as to allow for the undulating motion of the bridge in gales of wind."

Memorandum.*—In the first instance, the boats had each one anchor ahead, and another astern, so as to meet the turn of tide, but, from the violence of the current, it was soon found that not less than two anchors at each end were necessary. In this case, great care is required to avoid fouling the anchors, and it will be best done by their being cast, as it were, 2 deep, by the alternate boats throwing them out as far from, and the others as near to, the bridge, as can be done with safety and convenience.

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* By a R. E. Officer who saw the bridge.

BRIDGE, CASK.—Plate XI.

When no Pontoons or Boats can be had, Casks, formed into Piers, offer a good substitute, they were thus used by Lieut.-Colonel Goldfinch, R E, over the Nive, in January 1814

The Chatham practice is given, as arranged by Lieut.-General Sir Charles Pasley, based on the above and other experience; leaving modifications to the circumstances of the service under which they are required

General Pasley's Bridge consists of rafts managed much on the same principle as the modern Pontoon Equipments, each raft composed of the ordinary superstructure laid on two piers of seven casks each,—put together as shewn in figs 1, 2, 3, Plate XI

The stores for such a raft will be—

14 Casks, or water-butts, 4' 3" long × $\left\{\begin{matrix} 2' 9' \\ 2' 2' \end{matrix}\right\}$ averaging 174 lbs in weight.

A 4 Side pieces, each 21' × 4" × 5"
B 4 Slings, each 36 of 2½" rope
C 24 Braces, each 18' of 1¾" rope
D 2 Transoms,
10 Baulks, (5 for Raft, 5 for Bridge,) } each* 22' 6" × 4" × 4½"
2 Spare baulks,
2 Anchors, cables, buoys, and lines
2 Boat hooks, besides oars, rack lashings, &c
Plank, or fascines, for the floor.

When a bridge is to remain in the water for any length of time, chain may be substituted for rope in the parts immersed, or, as was done on the Nive, the casks may be enclosed in an open frame of wood work

At open order, each raft will give about 37 feet of bridge, about 18 feet wide, and will bear Infantry, Cavalry, and a light 6 pounder

At common order, each raft will give about 31 feet of bridge, and will support a medium 12 pounder limbered up, complete with ammunition

When heavy artillery is to be passed, it must be towed on rafts consisting of three or four piers instead of two, the floor proportionally strong, thus the weightiest ordnance may be taken across, the platform being about 30 feet long × 18 feet wide

To insure stability, the piers should never be less than 20 feet long in any case

Cask rafts can be rowed with tolerable facility in still water, or in moderate currents, but not against a strong one or a high wind. In rapid rivers they are apt to have the stream end borne down, which must be remedied by giving a stream anchor and cable to each pier, secured, not immediately to the pier itself, but to a cask close in front, which is interposed as a breakwater, and which is attached to the end of the pier or the force of the water may be reduced by a projecting triangular breakwater of 1½ inch plank, instead of the detached cask

It is desirable to have the anchors and cables laid as moorings before the rafts are brought off to their stations, which are marked by the two continuous buoys supporting the ends of the cables If only a small boat or Blanshard's Infantry Raft, can be had it should be used in taking out the anchors, if not, a cask raft must be used, taking care to work and drop down the stream as much as possible

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* If these cannot be obtained in one length they must be made by lashing two shorter pieces together

The following Table is arranged in reference to Commissariat and Admiralty Casks, being those that may often be available, or will serve, by approximation, for others

Cask, &c	Content	Weight when empty	External Dimensions						Extreme Buoyancy in Fresh Water	Time* of putting together.		Remarks
			Head Diam		Bilge Diam		Length			Men	Hours	
	Imp gals	lbs	ft	in	ft.	in	ft	in	lbs			
Leaguer . .	161	230	2	6	3	1½	1	10½	1746	2	4	Used for water before the introduction of iron tanks
Butt . . .	110	168	2	2	2	9	4	4½	1173	2	3	
Puncheon .	72	135	2	1	2	4	3	5	691	2	3	Chiefly used for rum
Hogshead .	54	109	1	11	2	4	3	0	576	1	3	
Barrel. .	34	71	1	9	2	1	2	7	407	1	2	
Half hogshead	26	59	1	7	1	10½	2	4	292	1	2	
Kilderkin .	18	45	1	5	1	8	2	0	194	1	2	
Tierce. . .	37	58	1	9	2	1	2	7½	428	1	3	Beef and pork.
Irish barrel .	23	47	1	6	1	8½	2	4	275	1	2	

Hutton's Rule for contents of casks, modified for imperial gallons, becomes—

$$(39\,D^2 + 25\,d^2 + 26\,D\,d) \times L \begin{cases} \times\ 0003143 & = \text{content in lbs water,} \\ \times\ 00003143 & = \text{content in gallons,} \\ \times\ 000005013 & = \text{content in cubic feet,} \end{cases}$$

where D and d = bilge, and head diameters, L = length, all in inches

BRIDGE, TRESTLE.—Plate XI

These are chiefly applicable to rivers in hilly countries, where the stream—liable to sudden swellings—is generally too deep to be forded, and when a Pontoon, Boat, or Cask Bridge is not applicable, cannot be obtained, or cannot be forwarded

The trestles can be made of rough materials on the spot, or may be framed in the rear, passed on in pieces on mules, and quickly put together on the bank

To give stability when sudden risings may be expected, or when the *current* is strong, heavy stones may be piled up inside, strong sheer lines, or even cables, may be passed across, to which the heads are to be lashed as the trestles are laid, successively, large killicks may also be thrown out.—See fig 6, Plate XI

The figure given is nearly that of a Bridge by Lieutenant Wright, R P, attached to Sir Rowland Hill's Division in 1812 If of yellow pine, such a trestle *will weigh* about 9½ cwt, and the superstructure per bay of 15 feet, including cables, will be *about 16 cwt* in addition. In the above instance, fascines were used where planking could not be obtained.†

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* The workmen are supposed to be good, and the materials only to require putting together

† The Belgians use a *tripod trestle* —*Editors*

According to Sir Howard Douglas, Colonel Sturgeon, of the Staff Corps, threw a bridge over the Agueda, at the ford of Marialva, near Ciudad Rodrigo, 396 feet long on 16 trestles, which were well loaded with stones secured by coarse wattling which allowed the water to pass through

In the construction, care should be taken not to weaken the timber by mortises and tenons, or by halving If the pieces are to be carried, and used a second time, it would be desirable if iron and a small forge can be obtained, to make a certain number of bolts and screws for fixing the work together

BRIDGE, RAFT.—Plate XII

The last expedient that should be adopted by an army in motion,—to such it is an indifferent substitute for Boats, Pontoons or Casks, either when employed as a Flying Bridge (Trail, or Pivot), or as a Fixed Bridge

It has the lowest degree of buoyancy* and general manageability, and is inapplicable when the passage of a river is likely to be contested with animation

Its merits are, that, at the expense of time it can be constructed with less experienced workmen, that it saves carriage, as it can be only made of materials on or near the spot,—cables, and a few such stores, being all that is indispensable from the rear, that it is not liable to be sunk, and, if allowed to remain undisturbed, will last a long time with moderate repair

Plate XII gives the general form and construction The rafts should not be less than 45 feet long, they are best bound together by withes or ropes and stiffened with cross and diagonal braces They are most readily built on the water, but, if they must be made ashore, they should be put together across two parallel baulks, or trimmed trunks of trees, sloping towards and close to the river, so as to be easily launched. With numerous and experienced workmen, such a raft may be made in 5 or 6 hours An independent raft will require (on an average) two rows of trees at least to float as many men as can stand upon it, unless the trees are very large,—when they cease to be manageable, and are scarcely applicable

Whether they are to be anchored in connection with a sheer line or not depends on circumstances, the anchor, in such cases, may well be the fisherman's wooden killick† (see Plate XI fig 6), unless the bridge is to last for any time, or is liable to unusually violent currents Such were, however, used in the Passage of the Indus in 1839, and by a sufficient increase to their number and weight (even to ½ ton), very powerful streams over rocky bottoms may be mastered.—See Professional Papers, vol iv Paper VI

The figure is nearly the same as that given in Laisne's 'Aide Memoire'

BRIDGE, PILE AND SPAR.—Plates X XI

Piles are used merely to obtain supports either as piers or abutments they are especially applicable when deep and wide rivers are to be crossed, but the nature of the bed must be considered before any operation can be attempted

Pile-engines form part of the French Engineer Field Equipment the rough approximate expedients for supplying their place either as a ram or as a tilt-hammer, are too obvious to require a description

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* And if down for any length of time becomes water logged

† Clay secured by matting may be used —Editors

Spars, baulks, &c., can be applied as superstructure, to either a piled or any other pier or abutment, whether to form, or to restore, a communication. The series of such bridges as may be used in field operations gives much of the earlier history of framing and trussing, in reference to roofs as well as bridges. Of these,—the 1st would be merely spanning the opening, with timber sufficiently long, and covered with cross planks, or, in default of these, with fascines.

The 2nd, and next rudest form of arch (particularly observable in Egyptian architecture), is very strong, easy of construction, and of frequent occurrence in Nova Scotia (see Plate X. figs. 1, 2); the timbers being notched roughly into one another, as is done in building log houses. A few of the upper courses may be treenailed down.

The 3rd step is given in figs. 3, 4.

The 4th in figs. 5, 6. In the construction of this, the first thing is to form a horse, or trestle, on which the remainder of the work is to lie until secured: to effect this, cut a step, *a*, low down, and well in rear of, the arch, so as to admit of a strong party standing there to pull over, and hold up with ropes and by main force, the 2 pair of spars, *b*, *b*, *b′ b′* and the cross piece, *e*, previously lashed together, and fitted with 4 guys at each end,—thus firmly held up, 2 light and active men climb up, and lash *e*, *e*, *d*, *d*. A general framing being thus made, the rest may be added in the following order:—the remaining rafters, *g*—the cross pieces, *c′*, *j*, *j*,—the remaining collars, *d*,—the cross pieces *f*, *f*,—the frames, *h* (like ladders on their sides), going entirely across as intermediate supports, and finally, the joists and planking or fascines. Diagonal braces, *i*, *i*, *i*, must be used, to give general lateral stability during the process and at its completion.

The 5th, figs. 7, 8, applicable when 2 spars will not reach across: it may be executed in much the same way, paying great attention to fix diagonal braces as soon as possible, even if but temporarily.

Both of these can be more readily thrown across an open stream (where there is plenty of room to extend the guys, and put on main force in the first instance,) than, as above, in the repair of a bridge.

Figs. 9, 10, Plate X., figs. 11, 12, 13, Plate XI., are common in Canada.* In a roof, the weight is thrown on the rafters and the cohesive strain on the tie beam and king-post. In these Bridges, the tie beam bears the transverse strain, whilst the tendency is no longer to snap, but to crush, the rafters, as well as to pull up the king post, or force its head off. In fig. 11, the rafters, *a*, *a*, of fig. 9, Plate X., are represented by the shores, *b*, *b*.

The above, as elements, can be occasionally combined,—e. g.—fig. 3 with figs. 9 and 12, or they may be repeated as separate and successive arches, as well as extended in width, so as to be doubled or trebled laterally, as in fig. 13, &c., &c.

The minor details of construction, in the above, are left to the general experience of the Officer, but he cannot, in figs. 9 to 13, too carefully avoid crippling the main pieces, by halving, or by using mortises and tenons, dovetails, &c., all of these, not only enfeebling the whole, but (the mortise and tenon) rendering it difficult to take down a bridge satisfactorily for repair or removal, and the dovetails giving a treacherous hold, especially in the green woods likely to be used in field practice. In lieu of these, couplings should, as much as possible, be made by mere fishings covering and stea lying the abutments,—by the simplest kinds of keyed scarphing,—or by iron strapping if obtainable.

Troops should not be allowed to keep step in marching over Field Bridges, as they are rarely stable enough to bear the accumulating oscillations thereby produced.

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* See Professional Papers, vol. iii. p. 163.

to swim They sometimes use four horses; and in that case two are fixed to the stern These horses require no preparatory training since they indiscriminately yoke all that cross the river One of the boats was dragged over by the aid of two of our jaded ponies, and the vessel which attempted to follow us without them was carried so far down the stream as to detain us a whole day on the banks, till it could be brought up to our caravan By this ingenious mode we crossed a river nearly half a mile wide, and running at the rate of three miles and a half an hour, in 15 minutes of actual 'sailing,' but there was some detention from having to thread our way among the sand banks that separated the branches I see nothing to prevent the general adoption of this expeditious mode of passing a river, and it would be an invaluable improvement below the Ghats of India. I had never before seen the horse converted to such a use, and in my travels through India I had always considered that noble animal as a great incumbrance in crossing a river."—*Burnes' 'Travels,'* vol. ii page 216

BRIDGE —Reconstruction of

Communications may be re-established by all the preceding modes of passing rivers, those which seem most applicable to the repairs of broken arches are the simpler kinds of Spar Bridges, Plate X, and Rope Bridges Plate IX. At Dresden, Laisne states that well secured flat boats, bearing high trestles, were used as temporary piers Where stability can be insured, a simple 'horse'* may be substituted for the trestle

With reference to construction, as well as repair, of bridges, experience has shewn that in demanding labour and material, contingencies are not too high at cent per cent.

BRIDGE, Field.—Demolition of.

An enemy's bridge can be destroyed by sending trunks of large trees,—or considerable quantities of small ones, to accumulate faster than he is likely to be able to remove them, so as to throw a strain on his cables;—or by heavy floats loaded with stones, having a short and strongly fixed mast to prevent it from passing under the bridge

These may or may not be combined with fougasses in the shape of powder boxes arranged with a gunlock or a pistol inside, fixed to a projecting pole or poles so as to explode on striking the boats, &c

If any of the above be furnished with shells or grenades to deter men from approaching care must be taken to cut the portfires so as to explode at uncertain intervals

These attempts should of course be made, if possible, at night, from the nearest accessible point, and on having ascertained the set of the current as nearly as may be —*Chiefly from Laisné*

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* For a figure of this sort of horse see Plate XIII fig 3; it is a two-legged trestle

BRIDGE, Masonry.*—Demolition of. Plate XIV —*See also* 'Demolition'

In the destruction of bridges during the Duke of Wellington's campaigns, various methods were adopted, according to the circumstances of the case

The bridges in the Peninsula were usually of stone, the arches from 20 to 40 feet span semicircular, and of one stone of 18 inches or 2 feet in thickness The loading of the arches was sometimes of solid masonry, but commonly of loose stones or rubbish

The object required generally was to destroy one arch, and in order to give the enemy the greatest inconvenience and delay, the largest arch, and where there was deep water, was preferred, excepting when want of time or ammunition made it advisable to select a particular one that might appear weaker than the others

The simplest principle of mining a bridge was found to be by lodging the powder on the haunch of the arch, and as near as could be on the centre of the width of the bridge, with the line of least resistance through the arch

The best mode of forming the mine was where the side walls of the bridge above the piers were slightly built and easily got at, and the loading of the arch of loose rubbish a small gallery was then run in A, Plate XIV, fig 1, about 5 feet from the arch-stone, and when at the centre of the width of the bridge, a return was made to the arch, and the powder lodged against it There are not many occasions where this can be done under a very considerable time; but when practicable it has many advantages: the greatest resistance is obtained to the sides and above, the ammunition is less likely to get injured from wet penetrating to it, there is no obstruction to the road over the bridge while preparing, and less danger of accidents after it is loaded

In this case, the powder, saucisson, &c, are applied in the usual manner in mining; and the end to be lighted is kept within the surface of the wall, to be sheltered from the weather

The common and quickest mode of mining a bridge is by sinking down from the road above to the arch, and lodging the powder in one mass on the centre of its width To do this with good effect, the shaft, c, in fig 2 should be sunk where there will be the greatest resistance gained above and to the sides as at B As the arch gives so much more resistance than the materials with which it is loaded, the distance to the surface, therefore, should be two or three, or even four times more, at least, in those directions, than in that through the arch, in proportion to the nature of those materials

In this way arches have been blown down with 45 pounds of powder, and after five or six hours of labour

The shaft should be sunk on one side of the centre of the width of the bridge, as at c, fig 3, and a little return made at the bottom to gain that situation for the powder, by which means there will be more solid resistance above, and a greater width of road left open during the operation

In loading the saucisson was brought up the shaft to within about 1 foot of the surface of the road and then carried along a gutter or drain to the side of the bridge where it was lighted, whereby the road was entirely cleared, and a premature explosion from accident less likely to occur The upper surface of the road was drained off as much as possible to keep the wet from penetrating to the powder

When there is no time to sink a shaft as deep as might be wished, as great

* The whole of this Paper on Demolition by Lieut General Sir J F Burgoyne G C B, R E

resistance must be obtained as can be by sinking as deep to the arch as there is time for, and increasing the effect by a loading of as much stone or other heavy materials from the parapet walls or elsewhere as can be applied.

A bridge across the Carrion, at Dueñas, was required to be mined in great haste, and it was found that the loading between the arches was of solid masonry: an opening was therefore made down to the crown of the arch, D, figs 4 and 5, about 2 feet 6 inches only; 250 lbs of powder were lodged in rather a longitudinal direction along the width of the bridge, and a loading, C C, fig 4, applied of heavy stones and rubbish, as high above the road of the bridge as could be, without preventing carriages from passing when fired it made a gap, E E, E, E, across the bridge, of 15 feet, which was about half its span

The French declare that 100 pounds of powder, laid on the crown of an arch, and without loading, would destroy it, but, in a well built bridge, I should be sorry to apply so small a quantity

As on service the time at command for this kind of operation is very uncertain, it is a common and good mode to commence preparing in two places, one on the crown of the arch and the other on the haunch, and then, if not allowed time sufficient to complete the latter and better mode, the powder can be applied on the crown of the arch, and exploded with or without a loading of rubbish, according to circumstances, and it is much better to do that than to lodge the powder in a shaft only partly sunk down to the haunch, although it should be deeper

In some cases where the bridge is very wide, and the operation can be carried on with nicety, it may be right to divide the powder into two mines, F, and G, fig 6, across its width, but in a rough operation, I would certainly never divide the powder, for although it was said once that a hole was blown through the centre of a wide arch, and a passage left on each side (which, however, I do not believe), if it was so, certainly that same quantity of powder that gave so nice a shock would not have injured the arch at all if divided

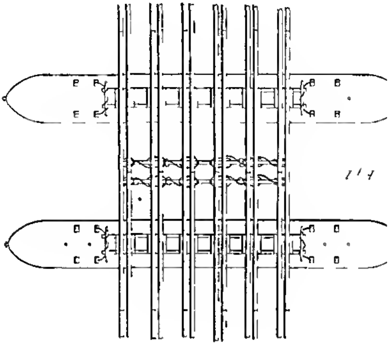
I have seen an instance where about half of the width of a bridge, F, G, H, fig 7, was blown down, which probably arose from dividing the powder in this manner

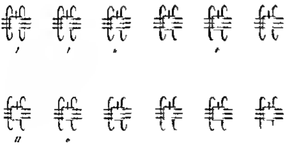
There can be no reason whatever for dividing the powder between the different sides of the arch, as at I, K, fig. 8, by doing so, a failure took place on the Corunna retreat, and if it succeeds, there can be little doubt but that one of the mines would have done as well. Wherever the powder is divided, the explosion of the whole should be simultaneous, the arrangements require much precision, and the chances of failure are of course multiplied

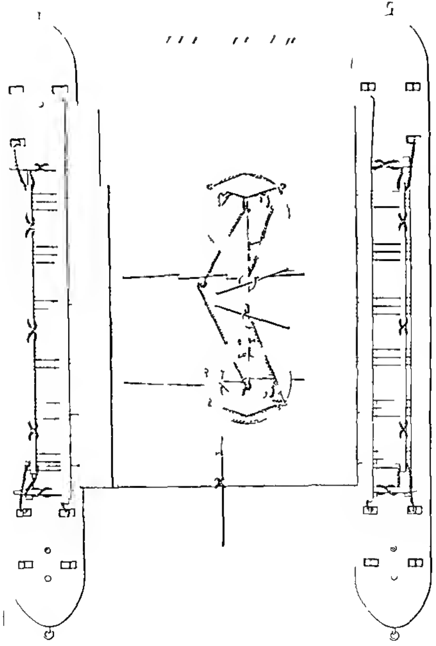
Where a bridge is narrow, there can be no occasion for sinking the shaft down to the arch much deeper than half the width of the bridge, as the want of resistance at the sides will render the additional vertical resistance superfluous On one occasion, a failure occurred from a shaft being sunk down to a pier with the intention of destroying two arches, but which, although great perpendicular resistance was gained, blew out at the sides, and left the two arches perfect.

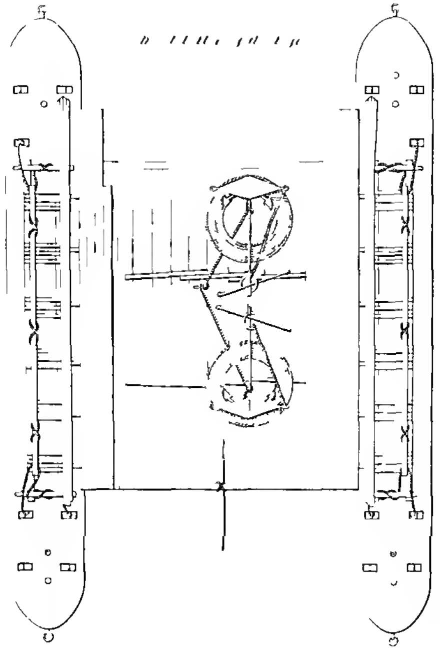
When the effect of a mine can be secured to cut through the arch, the greater resistance that can be given, even in that direction, the better, as it will increase the *effect over the whole width of the bridge*

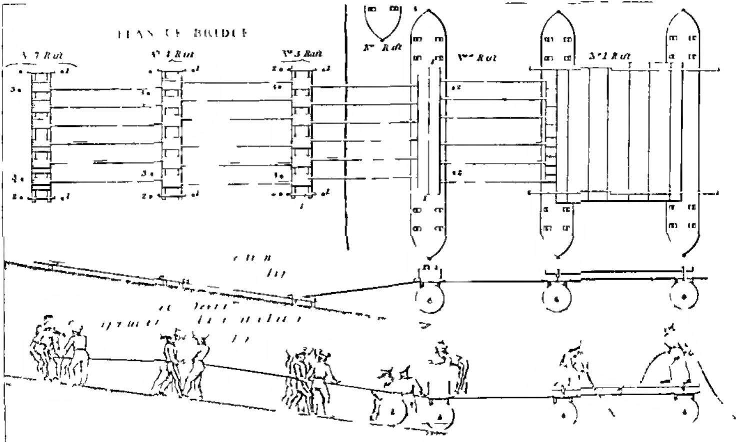
As it generally happens on service that the mine cannot be laid according to nice calculation, after applying it in the best way which circumstances will [illegible] et must be gained by increasing the quant[illegible] der Under the c[illegible] nt difficulties that might occur, it wa[illegible] en practicable, to [illegible] and even four barrels of powder, [illegible], for the destru[illegible] although one would usually be suf[illegible]










PLAN OF BRIDGE
No. 3 Raft

BENDS AND KNOTS USED IN PONTOONING

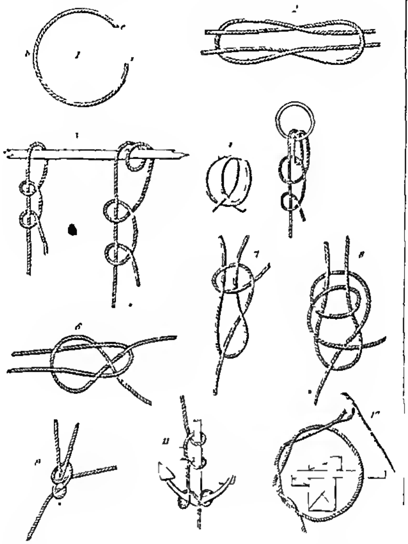


Fig. 1 [illegible] with th[illegible] common [illegible] [illegible] mains in the d[illegible]

Fig. 2 [illegible] used [illegible] the ends [illegible]

Figs. 3, 4 [illegible] used [illegible] fast [illegible] pointers and [illegible]

Fig. 5 [illegible] used for [illegible] the [illegible] and the [illegible]

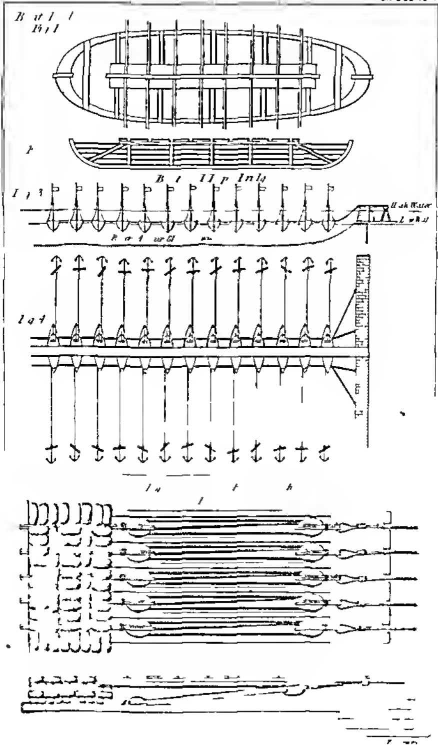
Fig. 6 [illegible] two cables

Figs. 7, 8 [illegible] cable [illegible] used for connecting cables

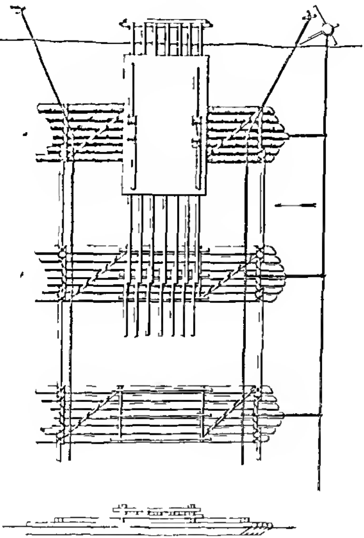
Fig. 9 [illegible]

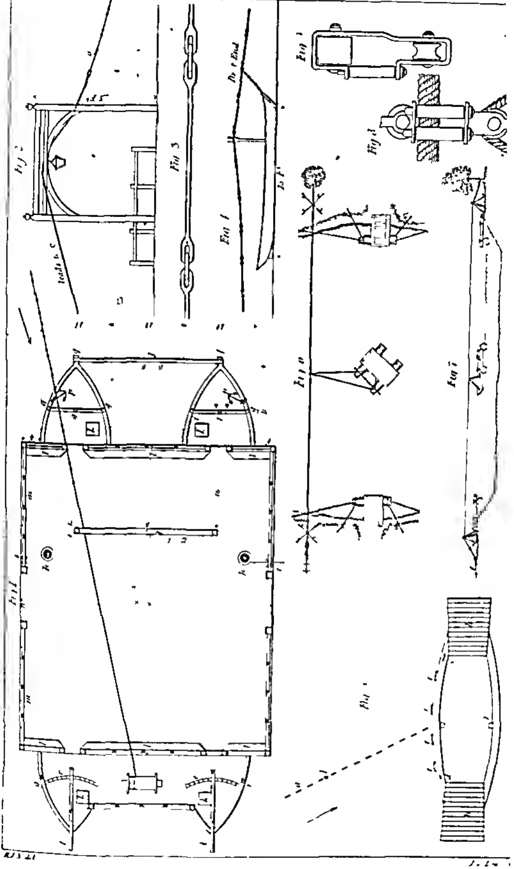
Fig. 11 [illegible] anchors

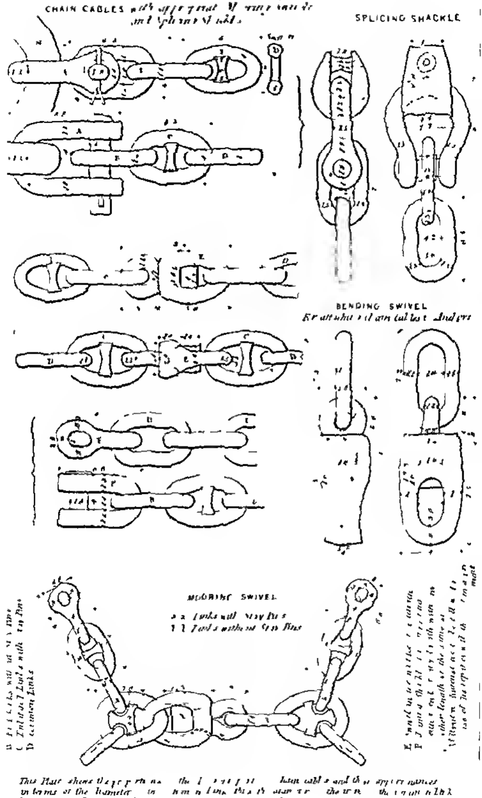
Fig. 12 [illegible] the Banks


High Water
Low Water

RAFT BRIDGE







This Plate shews the pr[illegible] the [illegible] Chain cables and th[illegible] appurtenances in terms of the Diameter [illegible] the [illegible] Link [illegible] D [illegible] B [illegible] as the diameter [illegible] D as the Unit

in Hawser laid in which correction has not been attempted as they are from different and highly respectable authorities It will be safest generally to take about two thirds of the last column of Cable laid as the practical strength for that description of rope

Table of Weights and Strengths of Cables and Hawsers

Cable laid — Tarred

Circumference in inches	Number of yarns	Weight per fathom	Strength of cables in tons	Breaking weight as obtained by actual trial *
In	No	lbs	Tons	
26	3523	139 2	Not ascertained	
25½	2384	134 01		
25	2240	129 16	113 5	101·25
24½	3122	124 02	Not ascertained	
24	2983	119 94	103 00	
23½	8880	114 05	Not ascertained	
22	2"36	109 24	95 00	
22½	26 3	103 58	91 00	97
22	8570	99 95	8 00	
21½	23 6	94 87	83 00	
21	8J08	91 87	9 25	
20½	2 60	85 0	5 75	
20	2088	22 09	72 00	76 16
19½	1930	7 9	6b 25	
19	1873	4 55	65 00	
18½	1 61	0 00	61 50	
18	1656	66 90	58 25	
1 ½	1584	62 63	55 00	54 45
17	1476	59 69	52 00	
16½	1404	55 67	49 00	
16	1331	51 85	46 00	
15½	1224	49 18	43 25	
15	1152	46 46	40 50	42 55
14½	1093	42 98	5 75	
14	1003	40 47	35 25	
13½	936	37 25	32 75	
13	864	24 90	30 85	
12½	92	31 91	22 00	31 4
12	756	29 3	26 00	
11½	681	27 03	21 5	
11	612	24 98	21 75	
10½	2 6	21 52	20 00	
10	504	19 96	12 00	17 8
9½	468	10 55	16 24	15
9	432	17 10	14 56	
8½	396	15 65	12 00	
8	324	12 21	11 52	
½	2 2	11 57	10 00	12 25
7	252	10 12	8 60	
6½	2 6	2 73	7 00	
6	189	" 48	6 42	
5½	163	6 25	2 41	
5	135	5 17	4 50	4 27
4½	109	4 18	3 64	
4	90	3 31	2 88	
3½	"2	2 53	2 00	
3	54	1 26	1 64	

Hawser laid

Circumference in inches	3 or 4 Strand Tarred: Number of yarns	Number of strands	Weight per fathom	Strength of hawsers in tons	Breaking weight as given by actual trial †	3 Strand White: Number of yarns	Weight per fathom
In	No	No	lbs	Tons	Tons	No	lbs
12	936	4	31 9	Not ascertained			
	9 4	8	82 70				
11½	252	4	31 63				
	852	8	30 15				
11	781	4	28 00				
	780	3	27 61				
10½	711	4	26 43				
	708	3	25 06				
10	642	4	23 84				
	640	8	22 93	21 00		732	21 59
9½	5 3	4	21 27	Not ascertained			
	5 3	3	21 20	18 90		660	19 56
9	521	4	19 27	Not as	24 85		
	516	8	18 57	17 00		588	17 34
8½	468	4	17 20	Not ascertained			
	464	3	16 56	15 20		528	15 07
8	416	4	15 45	Not ascertained			
	428	2	14 67	13 40	22 03	468	13 81
7½	364	4	13 50	Not ascertained			
	360	8	12 29	1 80		408	12 02
7	313	4	11 61	Not ascertained			
	812	3	11 23	10 50		860	10 61
6½	261	4	9 0	Not ascertained			
	264	3	9 68	8 90		300	8 31
6	226	4	2 39	Not ascertained			
	228	3	2 25	7 60	11 66	264	7 8
5½	191	4	09	Not ascertained			
	192	2	6 93	6 40		216	6 37
5	157	4	2 82	Not ascertained			
	156	2	5 73	5 30		130	5 10
4½	130	4	4 83	Not ascertained			
	330	2	4 64	4 20		141	4 24
4	114	4	2 81	Not ascertained			
	108	2	2 6	3 40	6 21	100	2 12
3½	"6	3	2 82	2 60	6 23	84	2"2"
3	60	3	2 06	1 90	2 11	60	1 0
2½	42	8	1 42	1 40			
2	2"	8	92	·90			
5½	56	2	52	50			
5	9	3	83	·25			
3	6	8	27	13			

* This column was obtained from 95 actual trials at Woolwich by the hydraulic press

† This column also from 95 actual trials at Woolwich

* The strength of white rope was not ascertained but it is always greater than that of tarred rope

R. J.

CAMEL—with reference to Egypt, Syria, India, and the adjacent countries

The camel is used in the East as a beast of burthen from 3 to about 16 years of age, and in hot sandy plains, where water and food are scarce, is invaluable

With an army, however, generally speaking, it is not so valuable as the mule or horse.

The camel under a burthen is very slow-going, about half the pace of a mule, or from 1½ to 2 miles per hour, he can, however, travel 22 out of the 24 hours, and only requires food once a day

His load varies exceedingly in different countries In Egypt it is as high as 10 cwt.; and for the short distance from Cairo to Boulac, even 15 cwt is, I believe, sometimes carried

But in Syria it rarely exceeds 500 lbs, and the heaviest load in the Engineer equipment for the Army of the Indus is stated to be 4 cwt 48 lbs., independent of the pack saddle About 400 lbs is a sufficient load on the march.

The pack saddle or pad is secured in its place by the hump on the back, a hole being made in the pad to let it come through, also by a breast plate and breeching, no dependence is placed on the girth, which is not kept tight

The camel, from his great size, averaging about 7 feet to the top of the hump, and 8 feet from his nose to his tail when standing in a natural position, is capable of carrying light field artillery, and the 12 pounder mountain howitzer, which, with its side arms, weighs from 330 to 350 lbs The bed or carriage is carried by a second, and the ammunition by a third camel

From his size too he carries with ease large articles, such as long poles planks, &c, and would be admirably adapted for the conveyance of Colonel Blanshard's small pontoon bridge—See Plate.

A camel would carry with ease two pontoons, with their saddles fixed, and several small stores

The calculation of one camel for every pontoon would be ample for the carriage of the complete pontoon equipment

Ten pontoons, with their superstructure complete, weigh about 26 cwt This would therefore allow a sufficient number of spare camels

In rocky ground the camel is apt to slip and his fore feet then are frequently spread out right and left when this is the case, he splits up inside the arms, and dies, or becomes useless

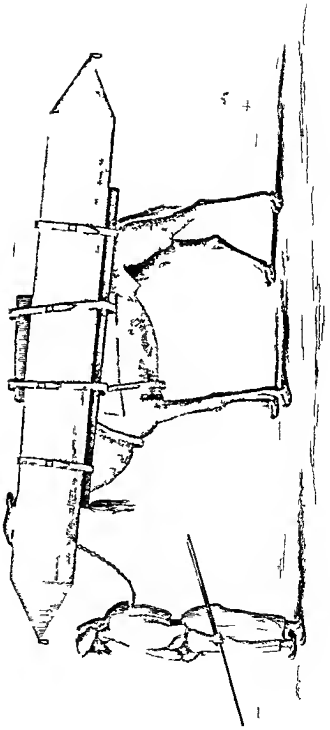
The camel, though patient and obedient to his keeper, at whose command he lies down to be loaded, is frequently very savage with strangers, and his bite is very severe

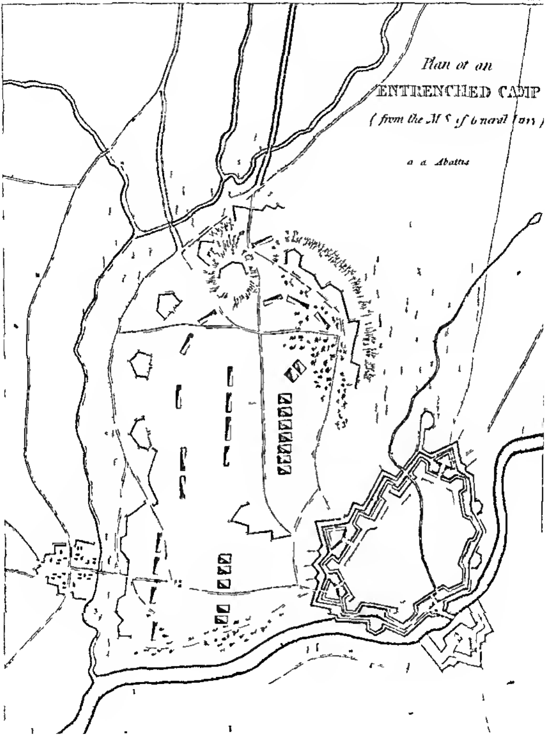
In Syria he is less valuable than the mule, and his price is from £10 to £15.

R. Alderson,
Lieut.-Colonel and Capt R E

The camel is still more liable to this 'splitting' (or rather dislocation of the shoulders) on slippery than on rocky ground, which is one reason why this animal cannot be generally used at the Cape, though usually hot and dry enough yet, in the rains, no ground can be more slippery than the clay soils of that country

In India also the camel stands high in the list of beasts of burthen, and is so employed by all departments—Artillery, Engineer, Commissariat, and Regimental. Its long sustained powers under the saddle are well known It is used in some instances for mounted Corps, and for the Rocket Service In some parts the natives mount swivels on them called 'zumbourouks,' or wasps.




Plan of an
ENTRENCHED CAMP
(from the M S of General
a a Abattis

The camel is as peculiarly suited to the deserts as the mule is to the mountain,—or as the bullock to open countries without roads,—or as the horse, immeasurably and above all, to civilized countries with roads.

It is the judicious application of these useful animals that renders their services *important and effective; failure results when their peculiarities are not consulted* as to the country in which they are to be employed. In the late wars, however, no animal was found to have such a general suitability as the horse.

Memorandum.—The 'Camel' above mentioned is often called the Dromedary, being the one humped variety, 'Camelus Dromedarius,' of Buffon and Cuvier. The two-humped or 'C. Bactrianus,' is a larger and more powerful beast, better adapted to carry burthens, and to wet soils but, like the Dromedary quickly ruined by those of a stony character. On the deserts, the latter, under the saddle, will go from 10 to 12 miles per hour, without water, food, or intermission for many hours together.

R. J. N.

CAMP, INTRENCHED.—The application of Intrenched Camps, as a strategic question, is sufficiently explained in the 'Sketch of the Science and Art of War,' at the commencement of this volume.

An Intrenched Camp does not necessarily imply fortifying ground on which the troops are under canvas, but the general term comprehends fortifying a space or enclosure, whether the troops are encamped, bivouacked, or hutted. For the Distribution of the Troops, see 'Castrametation.'

As regards the works for intrenched camps, they are similar to those placed in fortifying a position, and taking advantage of natural obstacles, and resources found on the spot; but the intrenched camp is generally taken up for temporary purposes, whilst the fortified position is of a permanent nature, at least during hostilities.

Intrenched Camps are seldom constructed in consequence of the immense labour, and when required, their use appears to be limited to the following objects:

1. For the security of an army or corps to cover a siege.

2. To intrench a corps of observation for the security of a line of frontier or territory whilst the main army is occupied with offensive operations in another direction.

3. For the defence of a frontier, placed in conjunction or immediate connection, with a fortified place.

Vauban attached great importance to this last proposition of constructing intrenched camps, and he considered that one or two positions thus taken up by a force in an unattackable site, except by a regular siege, would enable an inferior army between them to contend against an enemy greatly superior.—See Plate of an Intrenched Camp.

The following rules are generally adopted in the selection of ground for an Intrenched Camp.

1. The site supposes an advantageous ground to which it is only necessary to add some artificial assistance. The fortifications are disposed as if they were the enceinte of a place, of which the bastions, or works are detached and closed by the gorge, to form so many separate forts. Curtains, if used, may be added but not joined to the bastions, in order to leave sufficient passages for the troops. One of the principal considerations in the choice of a site is having sufficient depth for the formation of the troops, and the ground should not be open to a cannonade from the neighbouring heights,—and all villages within 1000 yards should be occupied, and all obstructions within that distance removed.

2 An inaccessible position is not always taken up, without it can be easily succoured, if necessary; as an intrenched camp seldom has all the resources for a long defence, and the means of retreat should be considered.

3 The junction of two rivers frequently offers an advantageous site for an intrenched camp; particularly in connection with a fortified place, as such a position is difficult to blockade, and easily succoured

4 An ample supply of stores, ammunition, food, fuel, forage, and water, is necessary to meet the object of occupying the fortified camp; for without these, the expense and labour are thrown away

The detail of construction will be found under the head of 'Field Fortification' and their application is further exemplified in the 'Defence of Posts, Villages, and Open Towns,' for an Intrenched Camp is a judicious combination of these resources, taking advantage, as before observed, of natural obstacles, such as inundation, marshes, bog, or precipitous ground G G L

CAPONIÈRE —This description of defence, when intended to be occupied, is only suited to permanent Field Fortification, on account of the great relief necessary to cover it, and the labour and expense attendant, if on a footing likely to be efficient

Fig 3, Plate I, shews the lowest section that can be given in this case, and even then the principle of having the loopholes 8 feet, at least, above the ground, has been sacrificed to reduce the height of the rampart as much as possible It is not, however, requisite that the whole work should have the dimensions of figs 1, 2, near the salient taking advantage of the extra height to establish a cavalier, the parapet may soon drop to an ordinary section, as at A much of the earth from the ditch in the neighbourhood of that point will be required for the completion of the salient and its glacis

Such a caponiere becomes a complete wooden house (shewn in plan by *e, f, b′, e′*, fig 1, Plate I), built on the level of the bottom of the ditch, being let into the escarp at one end, but separated from the counterscarp, and communicating with the work by a gallery

With reference to fig 3, Plate I, it is presumed to be proof against musketry and splinters of howitzer shells, though not against the shells themselves, any more than the sides of a ship are proof against shot The loopholes are only 5 feet 8 inches above the ground instead of 8 feet, as above explained, but they may be protected by abattis to such extent as will not mask their fire—ditches in front being objectionable as accumulating stagnant water* Sufficient width is given to admit of two opposite ranks loading and handing the muskets to the men on the banquettes Spaces, *e, e*, fig 4, are left on each side of the tie beams for ventilation, they and the loopholes can be fitted with small sliding sashes

Eighteen or twenty men can sleep on the banquettes lengthwise, in extreme cases, treble that number will find shelter, if placed also on camp trestles and boards on the ground, to be packed up and put away under the banquette when not wanted as beds or tables Every precaution must be taken to preserve these caponieres dry, if to be thus inhabited the ends of the building should be kept from touching the earth by means of dry rubble, the bottom of the ditch sloped so as to carry off rain or spring

* Except in case of a gravelly soil through which water will pass freely; in clay or loam it will stagnate; and ditches will not preserve their dimensions, and sinking in rock for a field work can hardly be required

2 An inaccessible position is not always taken up, without it can be easily succoured, if necessary; as an intrenched camp seldom has all the resources for a long defence, and the means of retreat should be considered

3 The junction of two rivers frequently offers an advantageous site for an intrenched camp, particularly in connection with a fortified place, as such a position is difficult to blockade, and easily soccoured

4. An ample supply of stores, ammunition, food, fuel, forage, and water, is necessary to meet the object of occupying the fortified camp, for without these, the expense and labour are thrown away.

The detail of construction will be found under the head of 'Field Fortification,' and their application is further exemplified in the 'Defence of Posts, Villages, and Open Towns,' for an Intrenched Camp is a judicious combination of these resources, taking advantage, as before observed, of natural obstacles, such as inundation, marshes, bog, or precipitous ground.

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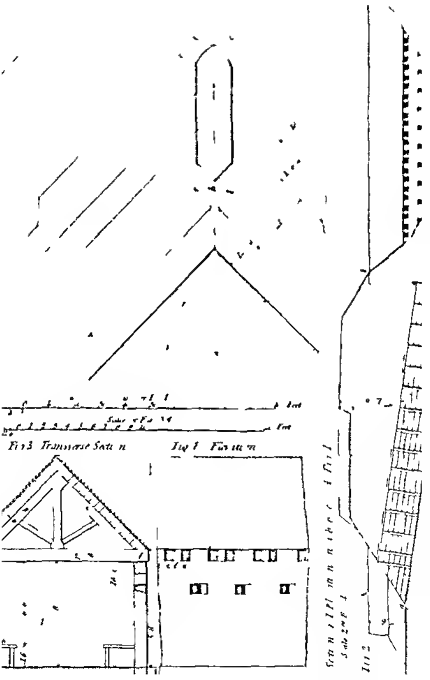
Such a caponiere becomes a complete wooden house (shewn in plan by *e*, *f*, *b′*, *e′*, *fig* 1, *Plate I*), built *on* the level of the bottom of the ditch, being let into the escarp at one end, but separated from the counterscarp, and communicating with the work by a gallery

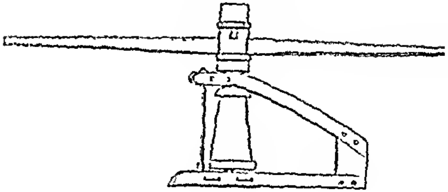
With reference to *fig* 3, *Plate I*, *it is presumed* to be proof against musketry and splinters of howitzer shells, though not against the shells themselves, any more than *the sides of a ship* are proof against shot The loopholes are only 5 feet 8 inches above the ground, instead of 8 feet, as above explained, but they may be *protected* by abattis to such extent as will not mask their fire—ditches in front being objectionable *as accumulating stagnant water* * Sufficient width is given to admit of two opposite ranks loading and handing the muskets to the men on the banquettes *Spaces*, *e*, *e*, fig 4, are left on each side of the tie beams for ventilation, they and the loopholes can be fitted with small sliding sashes

Eighteen or twenty men can sleep on the banquettes, lengthwise, *in extreme cases*, treble that number will find shelter, if placed also on camp trestles and boards on the ground, to be packed up and put away under the banquette when not wanted as beds or tables. Every precaution must be taken to preserve these *caponieres dry*, *if* to be thus inhabited the ends of the building should be kept from touching the earth by *means of dry* rubble, the bottom of the ditch sloped so as to carry off rain or spring

* Except in case of a gravelly soil through which water will pass freely, in clay or loam it will stagnate sand ditches will not preserve the r dimensions, and sinking in rock for a field work can hardly be required



It is sometimes, but improperly, called the Crab Capstan



CARCASS.—*See* 'PYROTECHNY.'

CARRIAGES *—(LAND AND SEA SERVICE.)

I. LAND SERVICE.

The carriages employed in the British Land Service are, 1st, Those which accompany an army into the field and through a campaign; and, 2nd, Those employed in the defence of garrisons, fortresses, and coast defences.

Of the former there are two classes, viz. those employed for field and mountain service, and those for sieges.

Field and mountain service. The carriages for field service consist of the gun-carriages for medium 12, 9, light 6 and 3 pr guns, 32, 24, and 12 pr howitzers, with their limbers and ammunition waggons; also forge, store, and Flanders waggons, rocket waggons, carriages for the conveyance of stores, infantry and cavalry ammunition, bridge equipage, intrenching tools, and hospital equipment.

The light 3 pr gun and 4⅖ howitzer are employed for mountain service.

For detail of their equipment, see article 'Mountain Service.'

The height of wheel is the same throughout the field service, viz. 5 feet, the fore wheels of the Flanders and pontoon waggons excepted, which are 4′ 2″, and the wheels of the hospital waggon, which are 3′ 6″. The track from out to out is the same for all, viz. 5′ 3″.

The limber is the same throughout the Service for gun, howitzer, gun ammunition waggon, ball cartridge, forge, and store waggons; but the ammunition boxes vary in depth according to the nature of ordnance they belong to. They are all of the same dimensions externally in the floor, and will fit any limber or waggon body.

All shafts are transferable from one carriage to another, and can be adapted to single, double, or treble draught, as may be required. The pole also may be used when necessary to resort to bullock draught.

Ammunition waggons are fitted to carry a spare wheel on the perch of the waggon

* By Captain Clerk, Royal Artillery.

body, also spare shafts splinter bars, perches, &c Every gun carriage carries a provision of spare horse shoes and nails, of which a proportion are fitted to the horses that belong to it The store limber waggon carries in the limber all the tools necessary for the wheelers and collar makers, together with material for the repair of harness, and the forge waggon in a similar manner carries all the tools necessary for the smiths and farriers' use together with horse medicines, iron work (fitted and in the rough), and a portion of coals

In addition to the carriages already mentioned there are for the heavy batteries of position,—the 18 pr gun and 8 inch howitzer carriages, with their limbers and ammunition waggons —forge, platform, and store waggons These carriages are fitted either for shafts or pole, according as it may be necessary to use horse or bullock draught The gun and howitzer carriages are of the same construction as those for the battering train

For all field guns there is provided a due proportion of spare gun carriages, which march with the Reserve

The second class of carriages which accompany an army are those employed in Sieges They consist of the gun carriage for 24, 18, and heavy 12 pr guns, the 10 and 8 inch howitzers, with their limbers and ammunition waggons, also platform waggons for the conveyance of heavy guns in convoy, and for the transport of 10 and 8 inch mortars and their beds —carriages for the conveyance of ammunition, stores, material for the construction of batteries and the service of the trenches

The same height of wheel is given to the gun and howitzer carriage as in the field service, viz. 5 feet, but the limber wheels are 3 feet 10 inches in diameter

The $5\frac{1}{2}$ and $4\frac{2}{5}$ brass mortars may be conveyed in store limber or Flanders waggons One waggon can convey from four to six $5\frac{1}{2}$ inch, or eight $4\frac{2}{5}$ inch mortars, including their beds, side arms and stores

All carriages belonging to the siege equipment are fitted for either horse or bullock draught

In order to distribute the weight more equally when travelling the carriages for heavy guns are fitted with two sets of trunnion boxes called the 'fighting' and 'travelling' 'trunnion boxes The field 12 pr medium and 32 pr howitzer are also fitted in this manner

To this class belong the gun carriages for heavy ordnance employed in the defence of fortresses and coast defences including traversing platforms and carriages for the local transport of ordnance ammunition, and stores viz sling cart sling waggon devil carriage &c

The garrison gun carriage consists of two brackets connected by transoms and bolts to axle trees and supported on iron trucks The carriages are raised to such a height as to enable them to fire over a 2 3' genouillere with a depression of 5° The length of axle tree is the same for all, in order that they may be mounted on the traversing platform

The other dimensions vary with the nature of ordnance

Depression carriages are somewhat longer than common garrison gun carriages and admit of a depression of 30° See page 219

The dwarf traversing platform and sliding gun carriage are a modification of the naval slide and carriage and are employed both in fortresses and coast defences They are suited to the Infantry parapet of 51 inches above the banquette, and, when required to fire, en barbette over a parapet of greater height the supports of the racers are raised in proportion For casemates a platform is used similar to the dwarf, but suited to a low genouillere without front trucks The radii of racers and extreme front projection are the same for both natures of platform (viz. 56-pr and

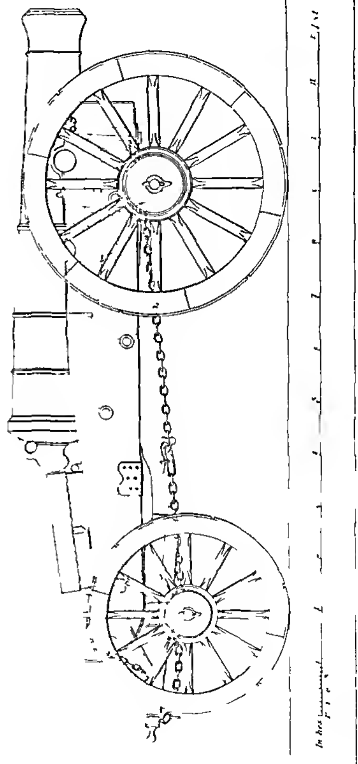
TABLE XV.*

Garrison Carriages, &c.		Wood (Block trail)	Iron
		cwt. qrs. lbs.	cwt. qrs. lbs.
68 pr. carronade		1 2 25	
42 pr.		10 1 21	
32 pr.		8 3 24	11 3 0
24 pr.		7 3 21	10 3 20
18 pr.		6 3 20	9 2 10
12 pr.		6 1 0	8 1 12
13 in. mortar	Old pattern		50 1 11½
10 in.	Old pattern		24 0 13½
8 in.	Old pattern		21 1 5½
5½ in.		1 0 10	
4⅖ in.		0 3 5	
13 in.	New pattern		31 0 0
10 in.	New pattern		15 2 22
8 in.	New pattern		7 2 10

TABLE XVI.

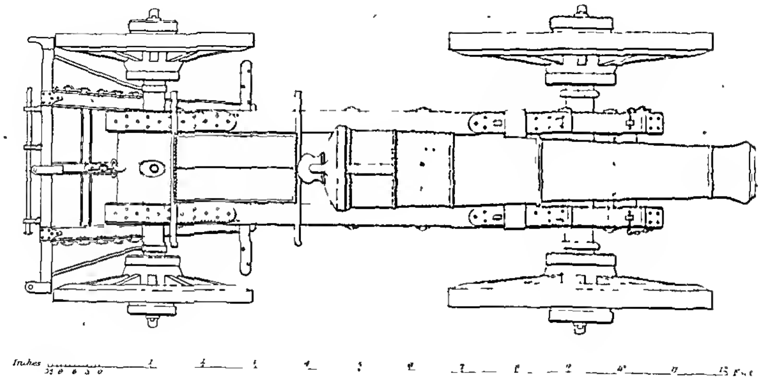
		cwt. qrs. lbs.	cwt. qrs. lbs.
Cavalry Forge Cart			10 2 18½
Flanders Waggon			15 2 0
Small Arm Ammunition Waggon	Limber	7 2 10	34 2 4
	Body	7 0 6½	
	20 Musket ball boxes	2 0 16	
	20,000 Rounds of musket ball cartridges	16 1 6	
	25,000 Percussion caps	0 1 12	
	29 Paper boxes for do.	0 0 10	
	15 sets of Horse shoes with nails	0 3 14	
	1 Horse shoe box	0 0 13½	
Note.—When flints are sent in lieu of percussion caps, the weight would be for	2000 Flints	0 2 16	0 3 9½
	2 Flint boxes	0 0 21½	
Sling Cart			16 1 17
Sling Waggon, Improved, substituted for the Large Devil Carriage			31 0 23
Gyns, Triangle	Large	9 2 22¼	12 2 19¼
	Blocks, &c.	2 3 25	
	Small	7 3 3	10 2 4
	Blocks, &c.	2 3 1	
Platform Waggon			21 1 23
Devil Carriage, complete, small			7 2 8
Baggage Cart			9 0 8
Store Limber Carriage	Body	10 3 8	18 3 18
	Limber	8 0 10	
Blanshard's Pontoon, large Carriage		13 2 21	42 2 12
	Appurtenances	28 3 16	
Ditto ditto small Carriage		9 0 0	22 2 5
	Appurtenances	13 2 5	
Hand Cart			4 3 4

* From Griffiths' Artillerist's Manual, third edition.



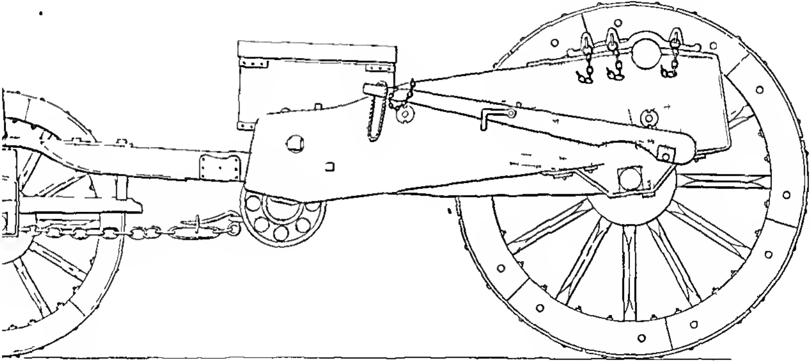
18 POUNDER.

Plan

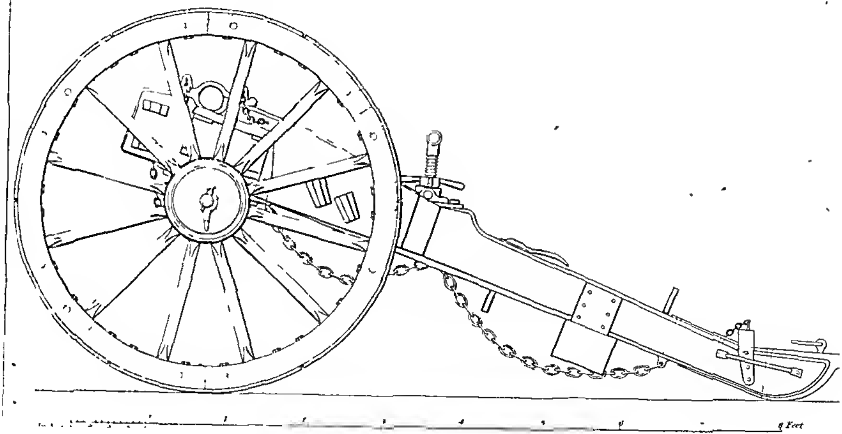


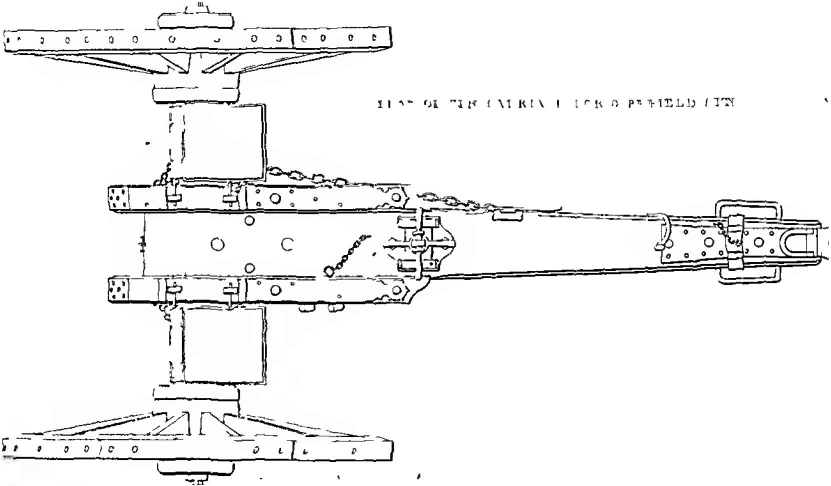
TRAVELLING CARRIAGE 8 INCH IRON HOWITZER.

Elevation



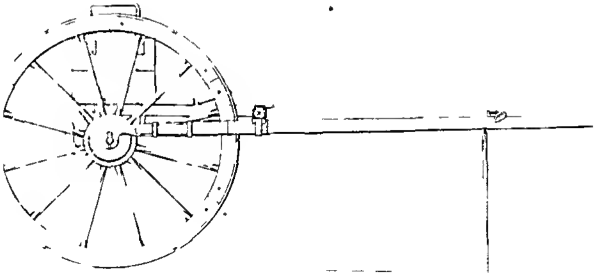
ELEVATION OF GUN CARRIAGE FOR 9 Pr. FIELD GUN.



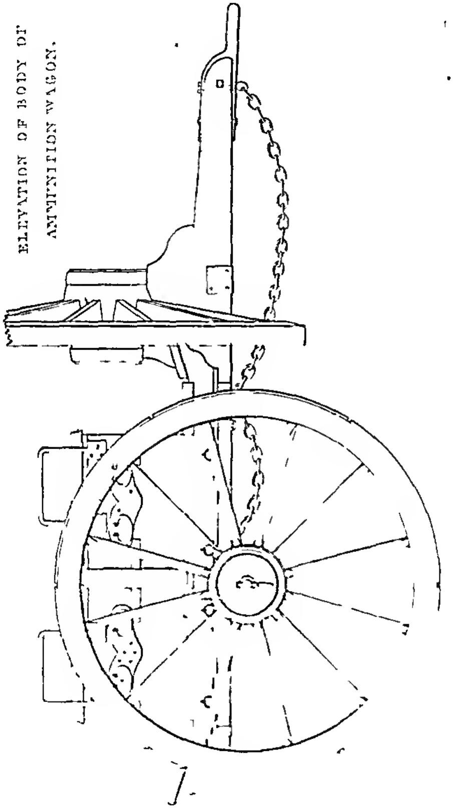


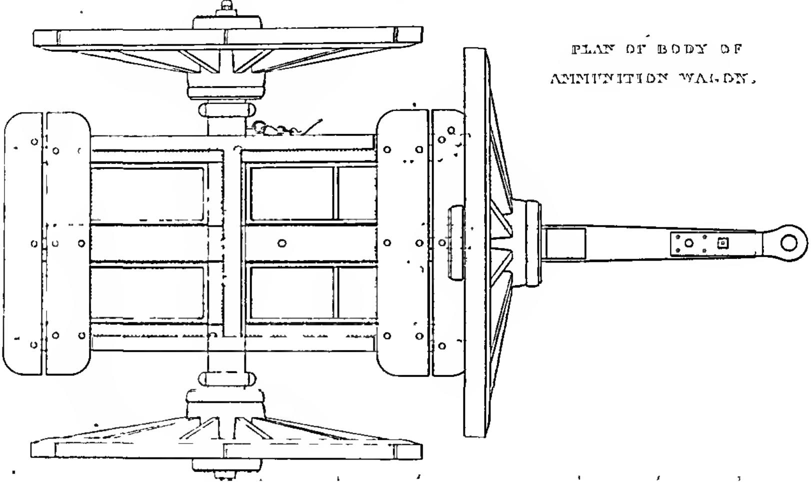
PLAN OF THE CARRIAGE FOR [illegible] FIELD GUN

ELEVATION OF LIMBER 9 Pr FIELD GUN



ELEVATION OF BODY OF AMMUNITION WAGON.

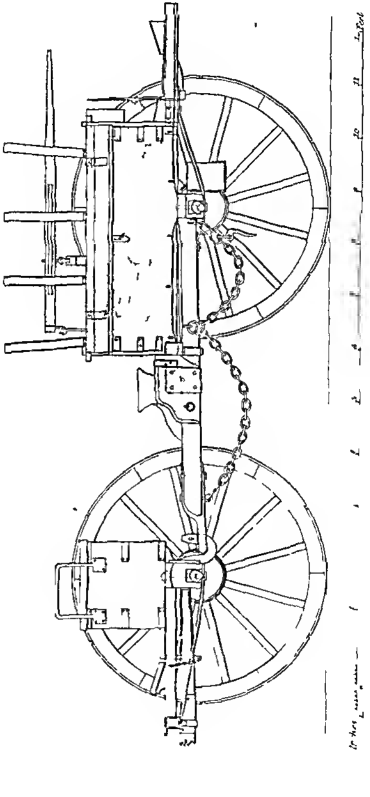




PLAN OF BODY OF
AMMUNITION WAGON.

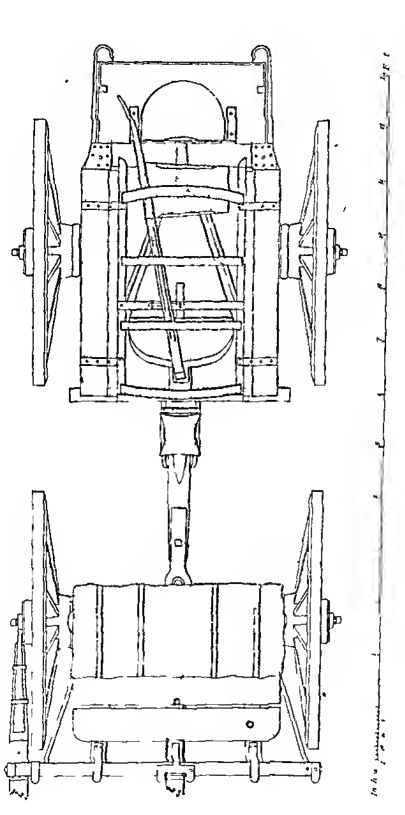
FORGE WAGON

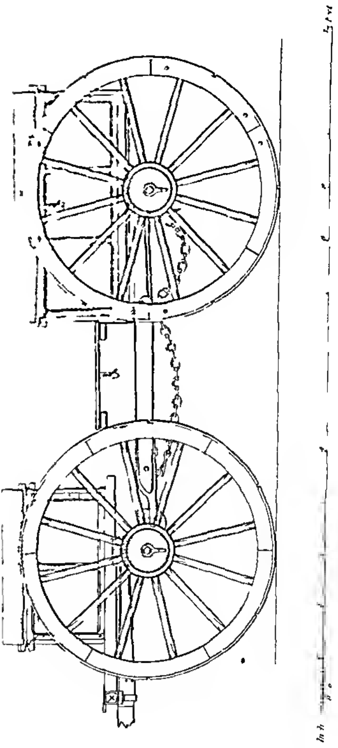
Side Elevation

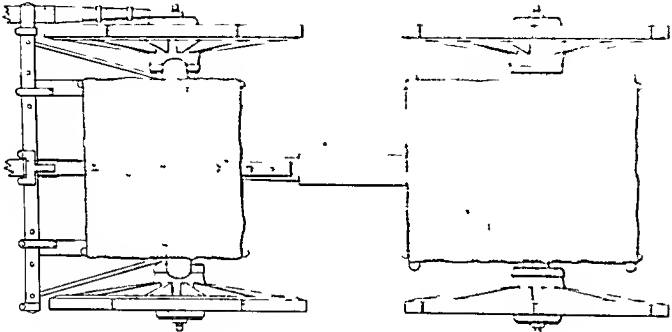


FORGE WAGON.

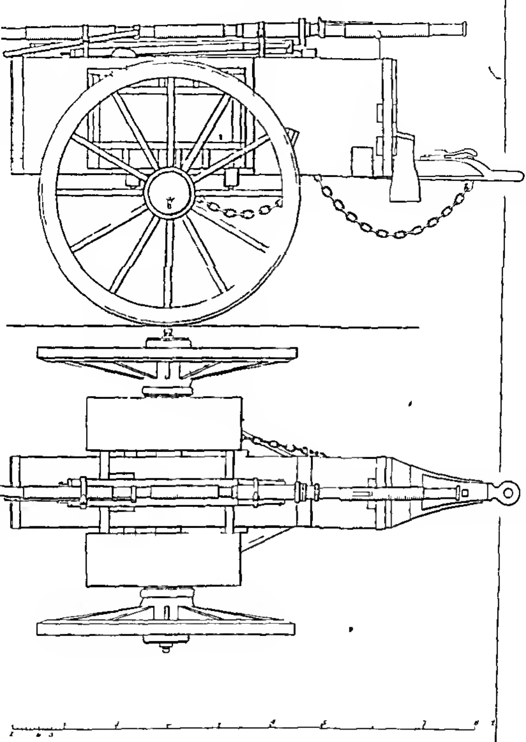
Plan

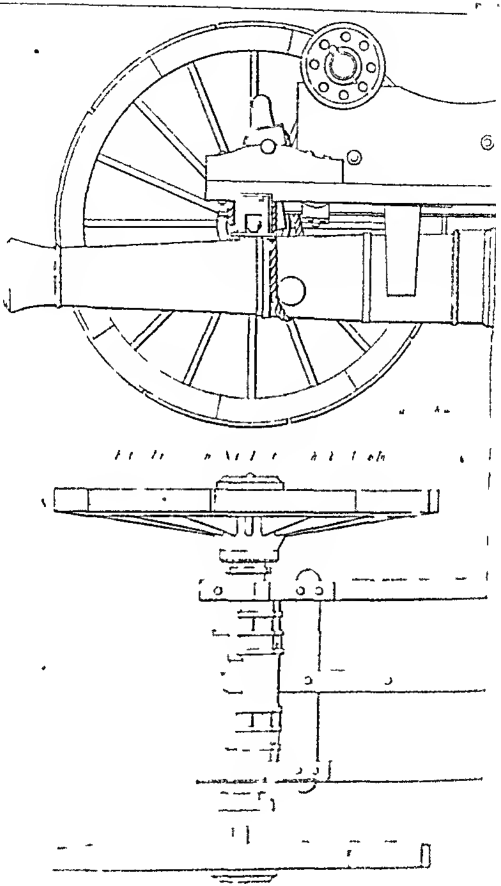


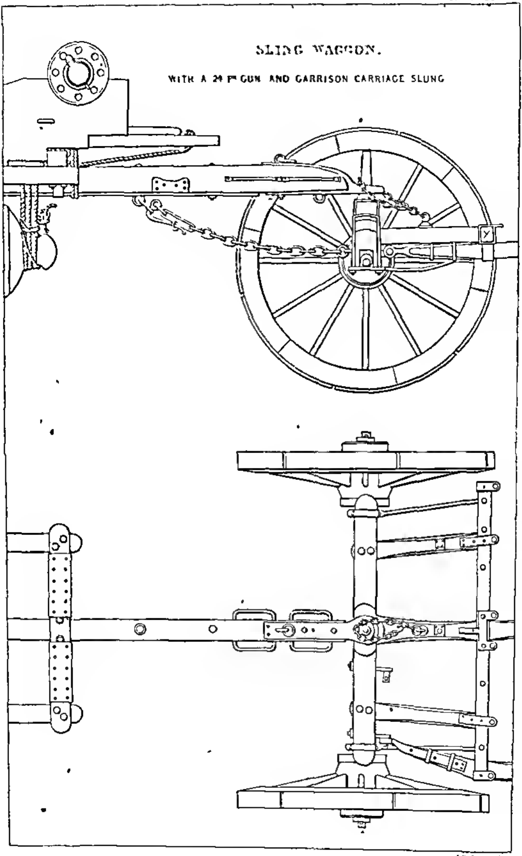




6 Pr ROCKET WAGON





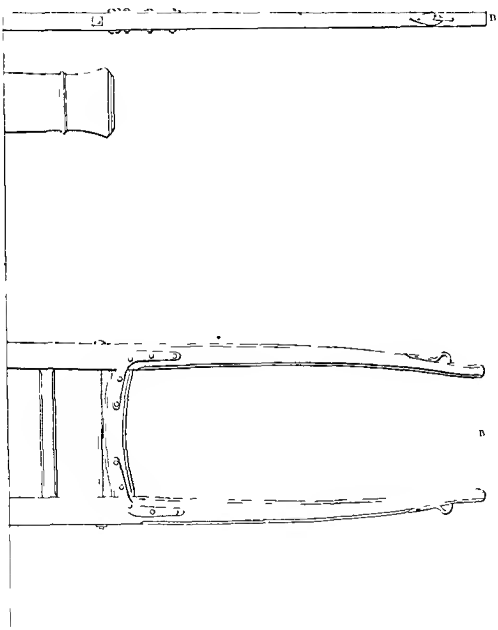


J B L del

Tho Bene & Hoh R R in FH

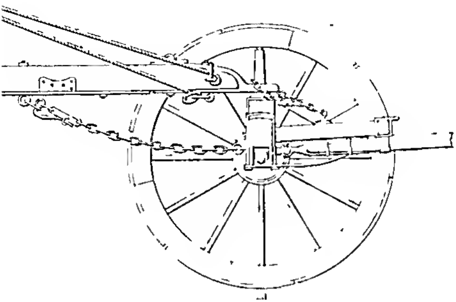
SLING CART.

WITH A 24 Pʳ GUN SLUNG



DEVIL CARRIAGE

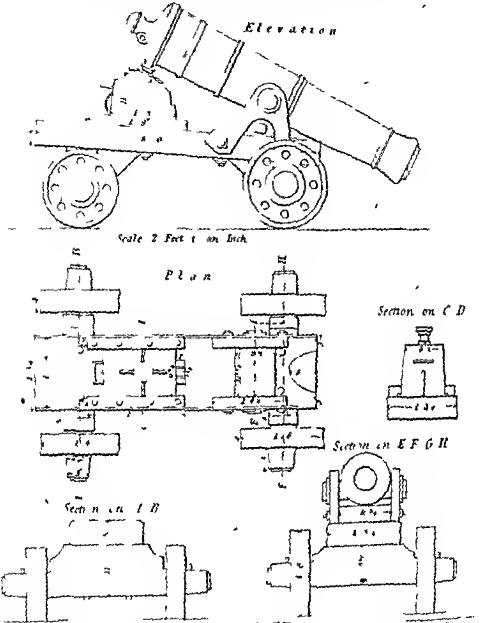
WITH A 24 P^R GUN & GARRISON CARRIAGE SLUNG



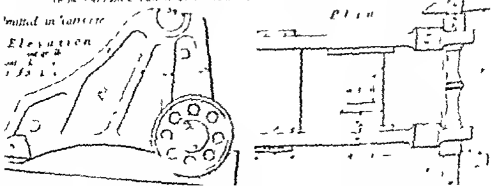
PLAN ELEVATION AND SECTIONS OF A

DEPRESSION CARRIAGE FOR A LIGHT BRASS 12 PR. GUN.

LENGTH 5 FEET CALIBRE 4.62 INCHES WEIGHT 12 CWT. 0 QRS. 3 LBS.



IRON CARRIAGE FOR A 24 PR. HOWR. ON A TRAVERSING PLATFORM



CARRIAGE FOR A PRUSSIAN 12 Pr GIVING 30 DEPRESSION

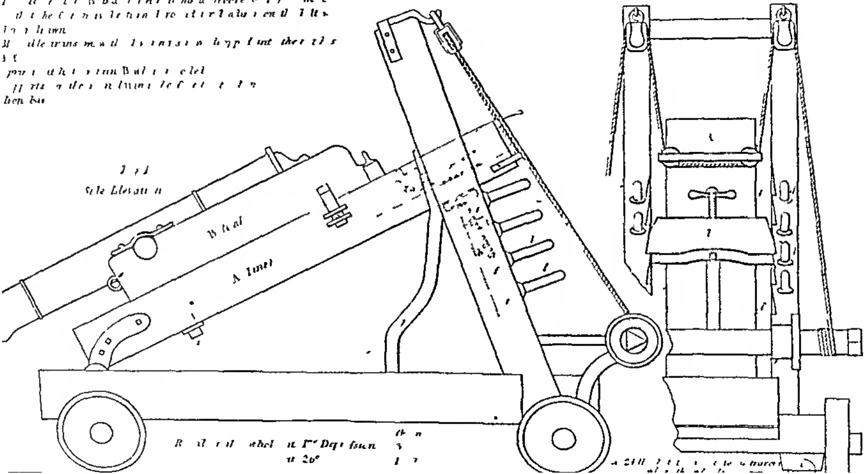


TABLE XVII

CONTENTS OF A FORGE WAGGON.*

See Plates

Bellows, pair	1	Small Medicine Chest, for Farriers' use	1
Anvil, with block	1	Hammers { Sledge	1
Coals, bushels	2	Hammers { Hand	1
		Hammers { Riveting	1
SMITHS' TOOLS IN THE LIMBER.		Cold Chisels { Rod	2
		Cold Chisels { Hand	2
Tongs, pairs	2	Punches { Rod	2
Slice	1	Punches { Hand	2
Ladle	1	Screw driver	1
Vice { Standing	1	Rasps { ½ round	6
Vice { Hand	1	Rasps { Round	6
Shoeing Smiths' tools set	1	Rasps { Flat	6
Jobbing Smiths' do do	1	Rasps { 3 square	6

CARRIAGES, DEPRESSION.

There is a general resemblance only between these and the common standing garrison carriage for the points of difference, compare them with figs 6 to 9, 'Carriage,' Plate I They admit of a depression of 30°, but after every round the piece must be brought to a horizontal position to be loaded, which is done by taking out the rear transom altogether —(See 'Artillery Tables G & H,' pages 66 & 67)

Elevation, Depression, and Height of an Iron 24 pounder Howitzer mounted on an Iron or Wood Carriage upon an Iron Traversing Platform

		Elevation	Depression	Height	
		With elevating screw	With elevating screw	From platform to axis of howitzer	Under swell of muzzle at 5° depression above the platform where the trucks stand
		°	°	ft in	ft. in
Iron 24 pr howitz. mounted on	an iron carriage	16	5	2 9	2 2½
	a wood carriage	17½	5	2 8	2 1½

CASK —*See* 'BRIDGE, CASK.'

CASTRAMETATION is the art of laying out Camps, whether the troops intended to occupy them are to be hutted, under canvas, or bivouacked.

Encampments on actual service may be divided into *Camps of Position*, and *Incidental Camps* taken up every night on a march by troops traversing a country where

* From Spearman's 'British Gunner'

CARRIAGE FOR A PRUSSIAN 12 P^R GIVING 10° DEPRESSION

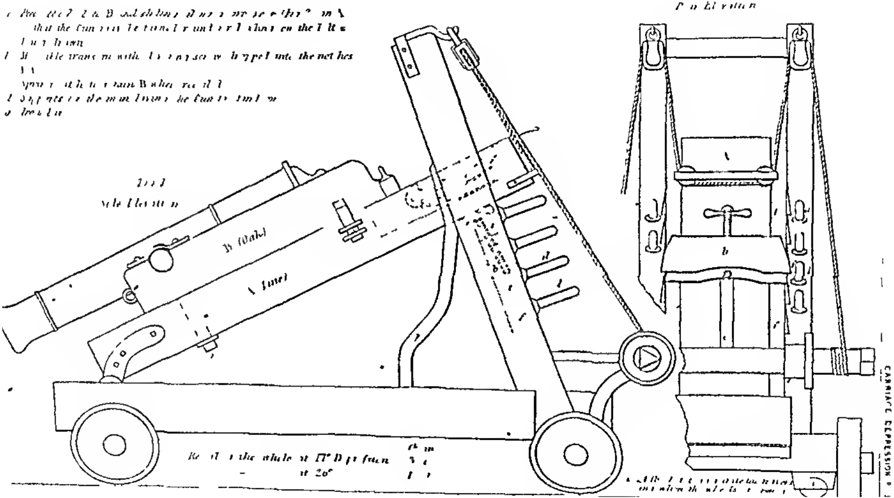


TABLE XVII.

CONTENTS OF A FORGE WAGGON.*

See Plates.

Bellows, pair	1
Anvil, with block	1
Coals, bushels	2

SMITHS' TOOLS IN THE LIMBER.

Tongs, pairs	2
Slice	1
Ladle	1
Vice { Standing	1
Vice { Hand	1
Shoeing Smiths' tools, set	1
Jobbing Smiths' do. do.	1

Small Medicine Chest, for Farriers' use	1
Hammers { Sledge	1
Hammers { Hand	1
Hammers { Riveting	1
Cold Chisels { Rod	2
Cold Chisels { Hand	2
Punches { Rod	2
Punches { Hand	2
Screw-driver	1
Rasps { ½-round	6
Rasps { Round	6
Rasps { Flat	6
Rasps { 3-square	6

CARRIAGES, DEPRESSION.

There is a general resemblance only between these and the common standing garrison carriage: for the points of difference, compare them with figs. 6 to 9, 'Carriage,' Plate 1. They admit of a depression of 30°, but after every round the piece must be brought to a horizontal position to be loaded, which is done by taking out the rear transom altogether.—(See 'Artillery Tables G. & H.,' pages 66 & 67.)

Elevation, Depression, and Height of an Iron 24-pounder Howitzer mounted on an Iron or Wood Carriage upon an Iron Traversing Platform.

		Elevation	Depression.	Height.	
		With elevating screw.	With elevating screw.	From platform to axis of howitzer	Under swell of muzzle at 5° depression above the platform where the trucks stand.
		°	°	ft. in.	ft. in.
Iron 24-pr howitz. mounted on	an iron carriage	16	5	2 9	2 2½
	a wood carriage	17½	5	2 8	2 1½

CASK.—*See* 'BRIDGE, CASK.'

CASTRAMETATION is the art of laying out Camps, whether the troops intended to occupy them are to be hutted, under canvas, or bivouacked.

Encampments on actual service may be divided into *Camps of Position*, and *Incidental Camps* taken up every night on a march by troops traversing a country where

* From Spearman's 'British Gunner.'

TABLE XVII.

CONTENTS OF A FORGE WAGGON.*

See Plates.

Bellows, pair	1
Anvil, with block	1
Coals, bushels	2

SMITHS' TOOLS IN THE LIMBER.

Tongs, pairs		2
Slice		1
Ladle		1
Vice	Standing	1
	Hand	1
Shoeing Smiths' tools, set		1
Jobbing Smiths' do do.		1

Small Medicine Chest, for Farriers' use		1
Hammers	Sledge	1
	Hand	1
	Riveting	1
Cold Chisels	Rod	2
	Hand	2
Punches	Rod	2
	Hand	2
Screw-driver		1
Rasps	½ round	6
	Round	6
	Flat	6
	3 square	6

CARRIAGES, DEPRESSION.

There is a general resemblance only between these and the common standing garrison carriage for the points of difference, compare them with figs 6 to 9, 'Carriage,' Plate I. They admit of a depression of 30°, but after every round the piece must be brought to a horizontal position to be loaded, which is done by taking out the rear transom altogether —(See 'Artillery Tables G. & H,' pages 66 & 67)

Elevation, Depression, and Height of an Iron 24-pounder Howitzer mounted on an Iron or Wood Carriage upon an Iron Traversing Platform.

		Elevation	Depression.	Height	
		With elevating screw	With elevating screw	From platform to axis of howitzer	Under swell of muzzle at 8° depression above the platform where the trucks stand
		°	°	ft in	ft. in
Iron 24 pr howitz. mounted on	an iron carriage	16	5	2 9	2 2¾
	a wood carriage	17½	5	2 8	2 1¾

CASK.—*See* 'BRIDGE, CASK.'

CASTRAMETATION

CASTRAMETATION is the art of laying out Camps, whether the troops intended to occupy them are to be hutted, under canvas, or bivouacked.

Encampments on actual service may be divided into *Camps of Position*, and *Incidental Camps* taken up every night on a march by troops traversing a country where

* From Spearman's 'British Gunner'

an enemy may be met with There are also, *in time of peace*, *Camps of Instruction or Exercise*, but under any circumstances, and whether the troops are hutted under canvas, or bivouacked, the principles here mentioned should be attended to Troops are however seldom *hutted*, except in Camps of Position

The situation selected for a camp should be healthy, not liable to be flooded, well provided with water, and should have abundant supplies of wood and forage close at hand also, if the troops are on actual service, it must be capable of defence, and should not be overlooked The British Army generally encamps by brigades, or divisions, independently The troops of each arm should be encamped in lines parallel to the probable line of battle, and in such a manner that all may form line directly in front of their camp without *confusion*, *by night* as well as *by day*, and *act efficiently*, the Infantry, if the country is open, being placed so as to be protected by the Cavalry, and, if the country is close, so as to cover the latter, whilst the Artillery should occupy the most commanding positions, (if possible, so as to flank the front of the camp,) and should be duly supported by Infantry and Cavalry

The flanks of the camp should be, if possible, protected by a village or river, and *care should be taken that* the prolongation of *the* lines may *fall* upon ground whence they cannot be enfiladed, and that the ground in front is favourable for a field of battle

The camp of each regiment, brigade, or division, should occupy the same space in *front* which it would cover *when drawn up in order of battle*, (*calculating upon* the effectives only,) and there should be ample space in front for manœuvring and intervals of about 400 yards between the fronts of the first and second lines and reserve, when several corps or divisions are together the interval between the flanks of battalions, or between those of brigades, may be taken at about a company's length

The Reserve should be placed so as to protect the approaches to the rear, and also to be capable of quickly affording aid to any of the troops in front

The communications throughout *the* camp, across its *front*, and *from* every *part* of it to the front and rear, must be rendered easy,—the lines of retreat being decided upon in the first instance

Fuel and water are amongst the most necessary items, and their importance will justify the choice of an otherwise inferior position

The rivulets near the camp should be dammed across at intervals, to retain the water for the supply of the troops, and at as early a period as possible Where the quantity is limited, an active police must be established, to see that the ponds are not drained for fish;—that cattle have not unrestrained access to it,—that horses are not watered in it,—and that the men do not bathe, and that clothes are not washed, in *the upper portions* *If the river is only* to be reached at points under the control of [illegible] the water [illegible] which command the approaches, but not so as to be out of sight, and sentries must be posted, so as not only to prevent the approach of an enemy, but the egress of the troops for the purpose of plundering, &c.

The several Parks should be established about 200 yards in rear of the camp, and remote from houses, so as to lessen the chance of danger from fire the carriages must be placed so that any of them may be easily moved at any time to the lines of retreat or advance.

The details of laying out Camps for Cavalry, Infantry, and Artillery, are given in figs 1, 2, 3, respectively Cavalry rarely encamped during the late war,—but fig 1 is taken from a Horse Guards' document, modified to the present circumstances of the

Service Fig 2 gives the practice as now established for troops in Ireland In forming from Line for a Regimental Camp, the battalion being in open column of divisions —

Grenadiers and Light Infantry stand fast	No 2 closes on No 1	The companies of the right wing which move, close to the front, those of the left wing, to the rear
	4 „ 3	
	5 „ 6	
	7 „ 8	Nos 2, 4 6, 8, and Light Company, counter march

The encampment of the 9 pr Field Battery allows for 164 horses as well as for the total number of Gunners and Drivers necessary,—on the Cavalry footing of 12 men per tent

In figs 1, 2, no arrangements are made for Sutlers Batmen, and Privies, they may be arranged in the rear, according to circumstances provided always that they lie within the rear guard

During the latter part of the Peninsular War, the general issue of tents to the Portuguese troops was discontinued, instead of these their blankets were edged with cord, looped at the corners, and with a squad of four men, these blankets could be thus secured to their muskets, crossed, so as to form a small ridge tent —(See Table on the next page)

HUTTING

For Winter or other Standing Cantonments, when towns or villages are not to be had —Huts should be made These have every shape, size, and quality, from the open screen of the Hottentot,*—the roof shaped Gypsey straw shed —or the lowest Irish turf sheeling †—to the cottage built of stone set in clay,—of raw brick —of cob — or of wattle and dab

In making cob, straw is trampled into the clay and the walls carried up in thin courses laid on in small shovelfuls at a time, within two planks on edge as a mould shifted upwards as the work rises Less than 12 inches thick of this is musket proof In constructing wattle and dab houses, there is first a plain frame work for the walls of upright poles fixed in the ground, and held together above by a wall-plate, the corner and door posts being stronger than the rest The poles for the walls may be about 18 inches apart and are wattled with rods so as to support the clay, which must be worked in by hand on both sides at once,—the first coat being left rough to allow a hold for the second To give stiffness to the framing diagonal bracing might be fixed to the walls inside, also across the corners of the wall plates as dragon ties The floor, of well rammed clay (mixed with cow dung) and gravel, high enough above the ground to keep it dry The fire place and chimney, in all cases of stone or brick, and best run up in a gable The thatch of the roof supported on rough slight rafters The whole whitewashed, inside and out, and a gutter run all round at a little distance outside

Those who are unacquainted with the virtues of cow-dung will be surprised to find how a clay floor is improved by being washed daily with a very thin mixture of it and water, which is perfectly inoffensive Cow dung also gives great toughness to the clay on the walls it is for the like reason used in pargeting

* Screens of interwoven branches to windward of the bivouac fire these give great protection from all weather except a downright vertical heavy rain If they are earthed up for a foot or two above the ground, outside so much the better

† Two triangular dry stone wall gables; rough pole rafters resting on the ground and covered in with sheets of turf a North American Indian would use sheets of birch bark

Table of Marquees and Tents for the General Service of the Army

Description of Tent or Marquee	No Men for	Extreme space in side pins		Weight, lbs Dry	Weight, lbs Wet	&c No Pins Small	&c No Pins Large	Packed in	Tonnage	Remarks
		ft ft							cub ft	
Common circular (or Bell) Tent	12 Cav or 15 Inf	17 diam	Tent Poles	56½ 9	92 11	42	„	V	3	It is probable that this weight may be somewhat reduced by and bye, the additional weight arises from an improvement in the canvas. Four of these Tents are allowed for each Regiment, as Guard Tents
			Total	65½	103					
Marquee large Field Officer or Captain: with Ticken lining	1	35×20	T P	140 33	210 34	96	4	V	12	Not allowed to Cavalry and Infantry of the Line; but they are issued for Artillery purposes occasionally
				173	244					
Marquee small Subaltern: with Ticken lining	2	31×24	T P	117 33	186 34	76	4	V	11	Do do do
				150	220					
Laboratory Tent Large circular.	„	42 diam	T P	169 83	290 85	96	4	V	13	For Artillery purposes only
				252	375					
Laboratory Tent Small circular	„	39 diam	T P	123 33½	187 34½	76	4	V.	7½	Do do Formerly called a Mess-Tent.
				156½	221½					
Ridge Tent	2	8×8	T P	20 8	30 8½	14	„	B	1½	
				28	38½					
Hospital Marquee	„	47×34	T P	346 82	560 84	180	4	V.	25	1 per Regiment allowed
				428	644					

Two mallets allowed for every description of Marquee or Tent. V (in ninth column) [illegible]

A great protection against fire may be given by thickly coating the thatch of the roof with whitewash, or rather, very thin mortar

Without departing from the principle of the length of the front being equal to that of the troops in line,—such an encampment may be so arranged that the huts may support each other by a flanking fire, especially from the Officers' quarters and the Guard houses

From the probable scarcity of suitable timber, the huts for the men may be only wide enough for one row of beds; a quarter for fifteen men at one pace per man, will thus be 37′ 6″ × 9′ in the clear, which, in a cold climate will require a fire place at each end If, however, timber can be obtained, it will be better to make the barracks 20 feet wide, there being no objection to a row of posts down the middle supporting the tie beams, if necessary

The following extracts from the Orders of the Light Division by Major General Robert Crawford between 1809 and 1811, and from the Queen's Regulations are given in reference to the chief points in the routine and associated duties, of Encampment —The former are marked by an asterisk.

* As a standing order, when circumstances permit, each regiment will be preceded by two Officers, for the purpose of taking up quarters, one of them will march 24 hours before the regiment, and on his arrival will receive the necessary information from the Assistant Quarter Master General, or from the Quarter-Master of the regiment preceding that to which he belongs The other Officer will march the same day as the regiment does, but sufficiently early to arrive at 10 A.M., when he will have the quarters pointed out to him by the Officer who went on the day before, and who, after having done this, will proceed to the next station

* The Camp colour Men viz one per company, under the command of the Quarter-Master Serjeant of each regiment, and one Officer for the column, will assemble at the Assistant Adjutant General's quarters every morning on the sounding of the first bugle, viz 1½ hour before the hour appointed for the march of the brigade

* The Officer in charge of these parties will march them in perfect order and as expeditiously as possible, to the next station where he will find the Officer gone forward with the Assistant Quarter Master General, and after marking out the quarters of each company, he will take care that each party shall remain together until the regiment arrives

* The Quarter Masters will, when practicable, march 2 or 3 hours before the brigade, or, if possible, the preceding evening, and as soon as they arrive, they will proceed to purchase the provisions, forage, &c, for their respective corps

* When regiments march separately, the Quarter Master Serjeants must be sent forward for the above purpose

* One of the first duties of Officers commanding regiments on arrival in Camp or Quarters is to cause the communication from the position or quarters of the regiment to all the principal roads by which the brigade may possibly march, to be thoroughly examined, and all obstacles removed, in order that each regiment, without the assistance of a guide, and without delay, may be able to move in the night, if required to whatever road in the vicinity of the Camp or Quarters may be pointed out for the assembly of the brigade

* On entering Camp or Quarters, each regiment must form on the same ground which it is to assemble upon in case of alarm, and when formed the ranks are to be opened.

* If the companies have to form up in succession, each will slope arms and open

ranks as soon as formed by words of command from its own Officer, but they must not order arms, or stand at ease, until directed to do so by the Commanding Officer of the regiment, which will not be done until the whole corps is formed.

* After the reports are collected as ordered (in a preceding Article), the men may be allowed to sit down, or walk about behind the ground of formation, which will be marked out by a sentry on the right flank of each company, but they must not be allowed to go 10 yards from the spot until the guards and pickets are placed, and all the other necessary arrangements are made, unless it rains hard, in which case the men (except those for duty) may be dismissed as soon as the reports are collected, but no state of weather, nor any other circumstance, is to prevent the corps being kept under arms until the reports of the absentees are regularly collected

* As soon as the corps are formed, and the reports collected the guards must be placed, and the men or companies warned for in or out lying pickets

On the arrival of a brigade or battalion on the ground destined for its camp the Quarter, and Rear Guards, of the respective regiments will immediately mount, and when circumstances require them, the advanced pickets will be posted. The grand guards of Cavalry will be formed, and the horses picketed. The men's tents will then be pitched, and until this duty is completed, the Officers are, on no account, to quit their troops or companies, or to employ any soldier for their own accommodation

The troops must at all times be kept in the most perfect readiness to turn out, and it is expected that in half an hour from the time they receive the order to march, either in the night or day, the army shall stand at the head of its encampment, that the baggage shall be packed, and the whole prepared to move This state of preparation is equally as essential in Cantonment as in Camp, and in both, the troops must be accustomed to march without any previous notice

Movements of troops, or dispositions of march, will not always be put in orders, but will be delivered to such persons only as they concern &c.

On arriving at a camp which is intersected by hedges ditches, unequal or boggy ground, regiments will immediately make openings of communication 60 feet in width

The ground in front of an encampment is to be cleared, and every obstacle to the movement of the artillery and troops is to be removed.

Commanding Officers of regiments must take care that their communications with the nearest great routes are open and free from any impediments

* In camp the best water will be pointed out before the men are dismissed, and the necessary directions for opening communications given

* The places for cooking in camp must be pointed out to the Orderly Serjeants of companies by the Captain of the day, and must be particularly chosen, with a view to avoid danger of fire, and for the greater facility of superintending all the companies must cook as near as possible together

Whenever a regiment remains more than one night in a camp regular kitchens are to be constructed

Necessaries are to be made in the most convenient situations and the utmost attention is required in this and every other particular to the cleanliness of the camp. If circumstances will allow the ground on which a regiment is to encamp to be previously ascertained, the pioneers should make these and other essential conveniences before the corps arrives at its encampment

* It must be explained to the men as a Standing Order, that when no regular

of parapet will give cover to the troops, unless each return of the approaches be directed very much in rear of the salients of the work under attack, which increases considerably the length of each return, and consequently the labour of forming it, and, even after this additional labour, the ordnance next the salients of the besieged place, which take the approach en écharpe, have a murderous effect.

"The depth required to obtain cover will, of course, be greater or less in descending a slope, according to the relative height of the ground to be opened for the approach and of the enemy's work.

"Another inconvenience attendant on carrying approaches down very deep declivities is that the rear of the trench is higher than the parapet in front, and many howitzer shells, fired ricochet, which miss the former, are stopped by the latter, and fall into the trench; and frequently, shells from mortars, pitched beyond the trench, roll back into it, in consequence of the steepness of the face of the hill.

"It is apparent that as the approaches nearly reach the bottom of the valley these evils increase, and that all the advantages of defence to be drawn from height of situation operate against the besiegers' trenches in a ratio according to the steepness of the descent and the relative height of the sides of the valley; therefore any plan of operations which necessitates carrying the approaches across a valley for the attack of a work on the opposite side, should, if possible, be avoided.

"From these various counterbalancing properties, resulting from height of situation, it may be concluded, that a fortress is not to be pronounced of great strength from the circumstance of elevated situation alone; for, even to form a moderately just opinion of its strength, it must be ascertained that its walls are all covered from distant batteries, that its interior be casemated, that the face of the height be under fire of the ramparts, or, if precipitous, that it be flanked on every point. If such, however, be found the case, height of situation must be considered to add greatly to the defensive powers of a place, and demands our respect.

CONSIDERATIONS ON THE DISADVANTAGES ACCRUING TO A PLACE FROM BEING COMMANDED

"Having endeavoured to discuss the real value of height of situation as a defensive quality, it may not be amiss to endeavour to ascertain the amount of the ill arising from its reverse, or a place being situated lower than the hills without it, and to inquire if it really be an evil of such magnitude as is generally supposed—the term 'commanded' being usually accepted as denoting everything bad, and many officers even carrying their feeling on this point so far as to believe that a very commanding height deprives a fortress of all powers of resistance

"The most prominent disadvantages under which a fortress labours from being commanded are, that the defenders of the work, and the interior of the place, are seen and exposed to the direct fire of a besieger's artillery; that its escarps are also exposed to be battered in a certain degree lower down, according to the greater or less height of the hill which commands them; and that in the same degree, the range of the enemy's projectiles is increased.

"Considered abstractedly, to be seen is rather an inconvenience than a positive ill; and as projectiles are never used at sieges from situations requiring their utmost range, the prominent evils from being commanded reduce themselves to two,—the greater exposure of the escarps, and the direct fire of a besieger's artillery on the garrison, whilst defending the works, and on the works themselves and their armament. Now the point-blank range of a 24-pounder being under 600 yards, and as it will not batter with good effect at a greater distance than 800 or 1000 yards, it would seem that all command in front beyond the latter distance is nearly harmless, except from the inconvenience it occasions to the garrison of being seen.

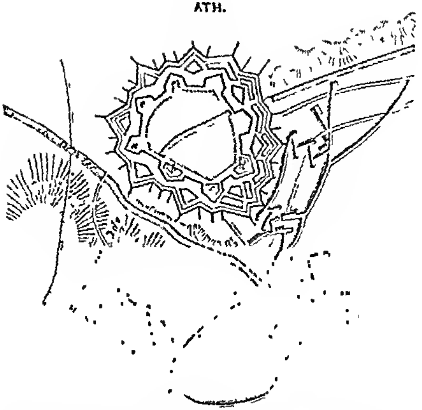
"Within the distance of 800 yards, being commanded, is, indisputably, a most serious detriment to a place, as its artillery may be dismounted, its defenders killed, its escarps laid open, and its buildings destroyed by a direct and accurate fire from the height; but the effects of such command may be greatly reduced, or even rendered null, by a just disposition of the works, and their relief. If a place be only commanded by one hill, and that of a moderate height, it requires no stretch of the imagination to comprehend, that if, instead of being built on a horizontal plane, as is customary, the works were constructed on a plane passing from some point in the interior, a few feet over the top of the hill commanding them, they would equally cover each other, and their parapets equally cover the defenders, as if the hill did not exist, and they had been built on a horizontal plane. Upon a similar principle, the exposure arising from the direct command of several moderate hills on the same front may be avoided, and even the works may be screened by the above method, and by the addition of traverses, parados, &c., from the command of such hills all around the place.

"But if the hills are of a great height, and near the place, the mischief arising from their command cannot be obviated by defilement, and even in many cases where it is possible to effect this defilement, the great labour and expense of so doing put it out of the question. Under such circumstances, the best resources are casemates and countermines, or to occupy the summits of the commanding hills by works of sufficient strength to restore the equilibrium of defence.

"There remains a disadvantage still to be mentioned, accruing to a place from being commanded, which is, that a besieger's first batteries, placed on the height which commands it, may remain open till the last moment of the attack without incommoding his near approaches, but when the height falls rapidly in one continued plane to the glacis of the place, this advantage is much counterbalanced by the difficulty mentioned before, of carrying the approaches down hill, and should the fall of the ground be gradual, it will frequently happen that the fire of the batteries on the height will prove almost as annoying to those in the advanced part of the trenches as to the defenders of the place.

"From these causes, command is far more prejudicial to the defence of those works of a place, the general prolongation of which it intersects, than to the defence of those works to which it is parallel, even if the distance of the lateral command of such height be greater than that of its direct command. This may be exemplified by reference to the attacks of Ath, in 1697 and 1706, by those great masters of the art, Vauban and Marlborough, and subsequently by the Count de Clermont in 1745.

ATH.



"Two fronts of the enceinte of that fortress, *a, b, b, c*, are traced parallel to Mont Feron, which, at 600 yards distance, overtops their ramparts 75 feet, the interval being a regular slope to the foot of their scarps, and which no exertion of art has been able to screen from the direct fire of artillery from so domineering a point in their immediate front. Still, in neither attack, did those Officers avail themselves of batteries on this commanding height to breach the scarp walls of the fronts opposed to it, or for establishing a commanding fire to ruin their parapets, and then carry their approaches almost unopposed down the face of the hill to the counterscarp; but, on the contrary, establishing on the height powerful enfilading batteries to ricochet the collateral fronts, the prolongation of which the command of Mont Feron intersects, Vauban carried his approaches towards the front *a, e*, to the right, and Marlborough his towards *c, d*, to the left, and to each, Ath fell an easy conquest

"The Count de Clermont, in 1745, followed with equal success the path traced by the British General, so that it may safely be inferred from these examples, that the side of a place most closely commanded, when that command is direct, is not consequently the weakest

"From the above statement it is apparent, that a fortress is not to be lightly and utterly condemned because it may happen to be commanded, for if the heights commanding it be at a greater distance than 800 or 1000 yards and do not enfilade any general line, they can have very little influence on the attack or defence. If the heights are not more distant than 600 yards and on one side only, the effects of their command may have been parried by defilement, and by the same art, a certain degree of strength may have been given to a fortification when closely surrounded by moderate heights, and even where defilement has been impracticable, casemates countermines, reverse batteries, and retrenchments, on the weakest fronts,

may have more than compensated the general exposure But if on examination these precautions are found to have been neglected, a fortress which is closely commanded by heights may safely be pronounced of little strength,—though there are innumerable instances in former, and some few in late wars, of such places having made good defences, from the intelligence of the Governor reserving the troops for the last stages of the defence, when the combatants become too closely in contact to admit of the interference of fire from distant batteries "

For *Relative* Command of Works, see 'Relief' in the Construction of Permanent and Field works

COMPASS, HARRIS'S MAGNETO-ELECTRIC —The inventor's object, in the application of his discovery of the steadying action of the copper ring, ' is the combination of great sensitiveness with stability and simplicity of construction, so that whilst the needle is free to obey the magnetic force of the earth in the most perfect way, it yet remains tranquil amidst the disturbing motions to which a ship is exposed and this stability is obtained without the aid of friction or other mechanical impediment, which often produce an apparent steadiness, or rather sluggishness of the compass (arising from indifference to motion), at the expense of accuracy

" When the horizontal position of the card is disturbed by any alteration of dip incidental to a change of latitude, it is to be corrected by moving the silver sliders on the needle

" Should the compass be out of use, care must be taken to let the needle hang freely in the meridian, and if put into a store room, or otherwise set by, the card and needle should be removed altogether, and placed with the needle downward in the shallow box provided for it —the north point being on that part of the keeper marked with a cross, thus × A good compass is liable to deterioration and damage when stowed away without regard to its magnetic properties, and without due care being taken to preserve the agate and the point of suspension in a perfect state "

On the writer's own observation of this compass, the needle was at rest in exactly one minute it is stated to have been so in 45 seconds at other times R J N

CONTOURING.*—This term is applied to the outline of any figure, and consequently to that of any section of a solid body, but when used professionally in connection with the forms of ground, or of works of defence the outline of a horizontal section of the ground or works, is alone to be understood by it

When the forms of ground or works are described by contours, or horizontal sections, these sections are taken at some fixed vertical interval from each other suited to the scale of the drawing, or to the subject in hand; and the distance of each, above or below some assumed plane of comparison, is given in figures at the most convenient places on the plan When the scale of the drawing is about 100 feet to an inch, 2 or 3 feet will be found a convenient vertical interval between the contours, and however large the scale of the plan, it will scarcely be found necessary to obtain contours with a less vertical interval than 2 feet. If the scale of the plan be about 250 feet to an inch, or the ordinary special survey scale of 4 chains to an inch, 5 feet will prove a convenient vertical interval, and with a horizontal scale of from 500 to 800 feet per inch, 10 feet may be taken as the vertical interval. The French generally employ an imaginary plane of comparison above the highest points in the plan, but there does not appear

* By Captain Harness, R. E

been fixed as are necessary to trace the part of the contour visible from the instrument, take the angle between the last point fixed and some point given in the trace, unless the situation of the last point is known by being close to some object given in the trace; lay down the direction of the line from the instrument to the last picket; chain the line, fixing the points of the contour by offsets, as they are successively passed; and add the work to the trace as it proceeds.

Thus if the Instrument be placed at *f*, its position may be fixed by measuring its distance from each of the pickets marked 260 and 270, the staff being read or adjusted when held at 270, may be moved to *g*, *h*, *i*, and 270 (as a check) in the boundary line B C, the exact place for the picket at *g*, *h* or *i*, being determined by moving the staff up or down the slope until the reading on the staff is the same as at 270 in the line A B

With the same position of the Instrument, if the staff be about 12 feet in length, the points *l*, *m*, *n*, in the contour 265, and the points *o*, *p*, *q*, in the contour 260, might be established, the staff being read, or adjusted at the picket 265, before it is sent along the former contour, and at the picket 260, before it is moved along the latter; by measuring the line *f*, *k*, these points may be determined by offsets, and the contours drawn upon the trace From the same point also, all the pickets required to describe the contours having the levels 260 and 265, and lying wholly within the triangle, may be fixed, since the telescope of the instrument would be higher than the summit they surround, and by measuring the line *f*, *t*, these contours could be added to the trace

It is not necessary to trace every contour instrumentally if the contour 275 has been thus traced, the two between 275 and 260 can be added very correctly by the eye while the contour 260 is being traced by judging each time a picket of the latter is fixed upon the trace, how the intermediate interval should be divided to accord with the appearance of the ground

Neither is it always necessary to fix the position of the instrument, for the pickets may often be surveyed without measuring from it, but wherever angles are used to set off the measured lines it is necessary, and may be considered the general rule

A single position of the instrument will seldom trace a contour,—fences, &c, as well as the form of the ground, preventing it. If the instrument were placed at *r*, to trace the level 255, the last picket would probably be at *s*, the angle between the corner of the house, *tr*, and the picket, *s*, might be observed, protracted on the trace, the line measured, the several pickets as far as *s* added to the plan, the instrument removed to *s*, and the contour completed

But the instrument might, in the case represented, be placed near *s*, its position being fixed if necessary by measurement from any of the points recognized on the trace as the angles of the adjacent fence, from this point the whole contour could be traced, neither buildings, fences, nor other objects intervening

If the triangle be very large, and the contours inconveniently long it may easily be divided, and a dividing line should if possible, be chosen, running along one of the ridges of the ground, for the ridges afford the best sites for the instrument in tracing, and the ridges and valleys are convenient situations for check lines because those measured to survey the pickets having to change their direction in crossing them, can then be closed upon points already fixed The line T V would be a good dividing line in the figure, running along the ridge on which the point *s* is marked, and fixing two points in each of the contours of the summit within the triangle

If it be required to contour a single feature of ground, not as part of a large survey, but for some particular object, run lines from the summit along the several ridges of the ground, fix upon these lines the points where the contours will intersect them, and trace as above the contours between them if the number of check lines be too few run them in the valleys also

D.

DAM, PERMANENT.—*See* 'River Navigation'

DAM, TEMPORARY.*

Dam,—a bank or obstruction built across a river or stream, for the purpose of raising the level of the water on the upper side of it

There are many objects for the attainment of which it may be necessary thus to check the course of a stream, and gain a head of water it may be requisite to turn it for a time into another channel, to inundate the ground in front of part of a military position, to make a portion of the stream unfordable, to secure depth sufficient to enable vessels of a given draught of water to navigate the stream, or to gain a power to be applied to mechanical purposes The works for the attainment of the first three of these objects belong more particularly to the class which Officers may be called upon to execute in the course of a campaign; and the details here given refer entirely to works composed of such materials as may be expected to be within reach of an Officer on service

Dams built for the purpose of inland navigation, or for that of securing a water-power, may be considered as having a more permanent character, and will be treated of in the article on 'River Navigation'

The first consideration in forming a dam across a stream is the choice of a proper site this must of course be decided with reference to the objects to be attained by the rise of water, but there are a few general rules to which attention should be paid.

In streams liable to sudden floods it would be advisable to carry the dam across the widest *part of the stream, so as to allow ample space for the water to flow over*, and thus to prevent any sudden and great rise above the dam, or it may even be advisable to carry the dam in an oblique line across the stream

In rivers where much drift timber is likely to be brought down, the dam should be situated below a bend in the stream where an eddy is formed, by means of which the collection and removal of the timber will be facilitated

The banks of the river or stream should be carefully examined with reference to the quality of the soil of which they are composed and their power of acting as abutments to the dam

When the site of the dam has been decided upon with reference to the principal objects which it is intended to answer, the necessary levels must be taken and the height of the structure determined upon this will depend in a great measure (when materials are plentiful) the plan to be adopted in forming the dam

In shallow rivers, when the bottom is rock, a dam of the section shewn in fig 1 may be easily constructed, of 10 or 12 feet in height The sill (*a b*) is bolted down to the rock with fox wedge bolts The standard (*b c*) is mortised into this sill, and a brace (*a c*) is framed into the two, making thus a strong vertical frame When the dam is high, a second brace may be inserted, and the horizontal distances between the frames diminished, but in general, 8 or 10 feet may be allowed as a fair distance between these frames from centre to centre. When the frames are securely fixed, a facing of logs roughly squared on the upper and under sides, is laid in front of them, across the bed of the stream. These should be got as *long as possible*, and

* Chiefly by Capt. Sir Wm Denison R. E , embodying some fragments by Capt. Bainbrigge R E

should break joint occasionally against a standard to which they should be sometimes pinned with a trenail, in order to prevent their moving

When the *water is intended to flow* over this dam, the space between the frames in rear should be filled in with blocks of rough stone, well wedged together and laid in steps, so as to break the fall of water on the bed of the river in rear If material of the proper quality cannot be found, or if the time will not allow of its being quarried and placed properly, this space may be filled in with earth and robble, and logs being notched down upon the back braces of the frame, stout planking should be spiked over these logs so as to present a smooth surface for the waste water to flow over, and to act as a protection to the stones, earth, &c below The front of the dam should also be filled in with earth, rubbish, &c., and if the surface of the rock is so uneven as to prevent the front logs bearing fairly upon it, brushwood and fascines may be placed in front, so as in some measure to close the spaces between the rock and the logs *

Construct on when the ground *is soft*

When the bed of the river is composed of sand, clay, or material too soft to resist *for any length of time the action of the water, the plan shewn in fig 2 may be* advantageously adopted This frame is composed of a sill, extending not only the width of the dam but also of the *apron in rear, notched down and pinned to three or* more sleepers, which are laid transversely to the stream, and sunk into the bed of the river. Into this sill the beam (*a b*) is framed at an angle of about 30° with the horizon, and supported in this position by the two struts (*b c*) (*d c*) at an angle of about 60°. These frames are placed at about 8 feet apart and upon them are notched the horizontal beams which carry the planking with which both the up and down stream sides of the dam are covered.

In order to prevent the water making its way under the dam, a row of plank piling (*d*) about 5 feet long and 4 inches thick should be driven in front of the upper sleeper, and a line of waling (*f*) upon this row of piling should be well spiked through the piles into the frame In order to secure the work more completely *against leakage, clay should be thrown in front of the sheet piling to a height of* 1 or 2 feet An apron (A), as shewn in figs 2, 3, is a necessary addition to every dam constructed across a river when the bed has not sufficient tenacity to resist the action of the water This may be composed of logs notched upon the sill pieces and covered with plank, or of rough logs notched and pinned down upon the sleepers in close contact with each other it should extend far enough below the dam to conduct the water away safely, and should have a row of sheet piling in rear, as shewn in fig 3

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When rough timber is plentiful, a dam, as shewn in figs 3 and 4, may be easily and quickly constructed thus *two or three rows of rough sleepers are bedded across* the stream, and upon these rough logs are notched and pinned at intervals of about *5 feet in the rear of the dam* Over one of these sleepers another transverse log is notched upon the first row of longitudinal timbers, and if the dam is a large one, perhaps a second transverse timber may be required The second row of longitudinal timbers is notched upon the second row of transverse timbers not exactly over the first row, but just so much clear of it as to allow of the end being notched and pinned upon the ground way or sleeper at the upper side of the dam, close alongside of the first timber Row after row of timber is thus placed, the dam constantly rising in rear *by the thickness of a log for each course,* while in front, all

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When timber is plentiful and the river is deep, a dam may be safely constructed to a great height of crib work, that is, of a series of rough cases formed of whole timbers notched together at the crossings, as shewn in fig 5 In framing a dam of this description, two logs are laid in a direction transverse to the stream, at the same distance apart as is intended for the width of the dam upon these cross logs are notched at distances of 6 or 8 feet, other transverse timbers are notched upon these, and the dam is carried up in this way until it arrives at its intended height Sometimes it may be advisable to divide the interior space into smaller compartments, by introducing more transverse timbers during this, very little impediment has been offered to the stream, which flows through the interval between the logs * When the crib work is complete, the spaces between the cribs are filled with stone, if it can be procured, or if not, with fascines, earth, &c, and a mass of earth and rubbish is thrown into the river in front of the dam, so that by degrees a mass is accumulated sufficient to prevent leakage. This work is carried on simultaneously from both banks; and as the water-way is checked, so the stream rises above the dam, rushing through the central space left for its passage The same process may be continued till the dam is completely closed, but as large quantities of earth, &c would be washed away in attempting to close the opening between the logs in this centre bay, the best plan is to prepare a frame to receive a sort of gate made of logs, which can be dropped down from above, and which will close the opening sufficiently to prevent much waste of material taking place †

When timber is scarce, fascines and hurdles may be used in the construction of dams In Holland and Germany they are very commonly employed for this purpose A course of large fascines is first laid, the length of the fascines being in the direction of the current, and each in as close contact as possible with its neighbours upon this a second course is laid transversely, strong pickets are driven through these two courses to connect them together and the heads of these pickets are wattled together, so as to make a kind of hurdle work, which serves to connect the whole more completely into one mass these layers of fascines are then continued in the same manner, each course being picketed to those below, and the pickets connected at top with hurdle work until the dam has attained the proper height. Very large rivers with a great depth of water have been successfully dammed up and their courses changed by works constructed in this manner Where the water is deep, gabions loaded with stones, square wicker baskets filled with stone, &c. have been used to form the foundation of the dam, and upon this a superstructure, as before described, has been raised

The above are a few of the most simple and of the readiest modes of constructing dams, modifications may, of course, be made to any extent two or more of these

* In executing this sort of work, the first logs float on the water, and are gradually sunk by the increasing superstructure

† Experience has likewise shewn that when the water is deep and even rapid the front of the dam may in like manner be formed of portions of crib-work two bays in length constructed ashore, dropped down into position and arranged on the arc of a circle in plan beginning from each flank, filling them as soon as properly placed This as the body of the dam, must be assisted and supported by slopes of clay &c, as in figs 1 2 —*Ed*

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When the water is intended to flow over this dam, the space between the frames in rear should be filled in with blocks of rough stone, well wedged together and laid *in steps*, so as to break the fall of water on the bed of the river in rear If material of the proper quality cannot be found, or if the time will not allow of its being quarried and placed properly, this space may be filled in with earth and rubble, and logs being notched down upon the back braces of the frame, stout planking should be spiked over these logs, so as to present a smooth surface for the waste water to flow over, and to act as a protection to the stones, earth, &c below The front of the dam should also be filled in with earth, rubbish, &c; and if the surface of the rock is so uneven as to prevent the front logs bearing fairly upon it, brushwood and fascines may be placed in front, so as in some measure to close the spaces between the rock and the logs *

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plans may be combined in the construction of a single dam,—as, for instance, the sides of a dam, when the water is shallow, may be made according to fig 1, and the centre part with cribs, as in fig 5

Plate I fig 8 Plate II fig 7 The flank of the dam should be secured by being let into the bank and puddled in front, and the earth or rubbish which is thrown in front should be carried up the river against the bank to a greater distance than at other points

As a general rule, the sides of a dam should be first constructed and the abutments made good serious accidents have occurred from a neglect of this precaution. Should it be decided to raise the water so as to inundate the banks on each side, the embankment to prevent the water thus raised finding its way round the flanks of the dam, these flanks should be completed before the dam itself is closed This embankment may be formed of earth; its section may be as in fig 7, about 3 feet thick at the top, which should be about 1 foot above the highest water line, the up-stream slope at least 2 of base to 1 of height, the down stream 1 base to 1 of height in case the soil is light and porous, it will be necessary to excavate a trench in the line of the embankment about 2 feet into the ground, and about 2 feet wide, to puddle this well with clay, and to form a wall of the same through the centre of the embankment till above the water line, as in fig 7, to render it water tight Where a current can act upon it, the base may be protected by stones and by planks, or fascines pinned down parallel to its direction In all cases ample provision should be made for the passage of the waste water when it is not allowed to pass over the dam waste channels should be made, and the passage of the water through these regulated by sluices either self acting (which is the safest plan) or worked by men Great care must be taken that the action of the water through these sluices does not tear up and wash away the ground below to an extent to endanger the structure Aprons (constructed as before described) must be laid in rear of the sluices except when these are fixed upon rock, and must be carried down to a distance proportional to the body of water discharged, and to the fall, also taking into consideration the nature of the soil * W D

DEFENCE OF BUILDINGS AND VILLAGES †

OF PLACING BUILDINGS, &C IN A STATE OF DEFENCE

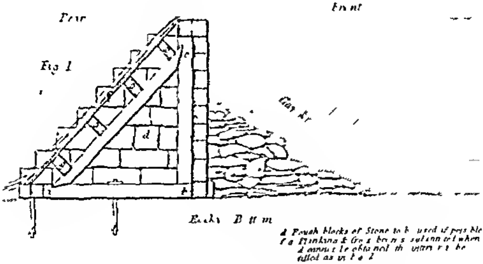
If a building forms part of a general line of defence, or is in the contour of the works round a town or village, the front and sides only may require being prepared for defence, for a force must not be shut up without a special object if, on the contrary it is an independent post, to be defended to the last, and is open to attack on all sides, every point must be equally looked to, and the means of retreat and of reinforcing it must be preserved, if considered necessary under the circumstances

The great art of making a defensible post out of buildings, and the out houses and walls that usually surround them, consists in selecting from the mass of objects before you what will answer the purpose, and sacrificing every thing else, making use of the materials to strengthen the part you wish to fortify It is more difficult to state any precise rules for such proceedings than for laying out works in the field, for in one case you generally have a choice in the form of your intended works, and a better

* Bridges may often be converted into excellent temporary dams by blocking up the archway, taking care that the mass thus formed is sufficient to support the accumulated body of water which must not be taken for granted with most bridges —Ed

† By Lieut Colonel Jebb C B, R E

Section of a Dam on a Rocky Soil



Section of a Dam on a Soft Soil

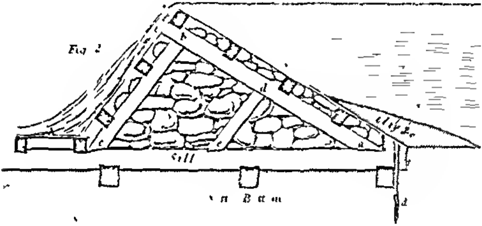
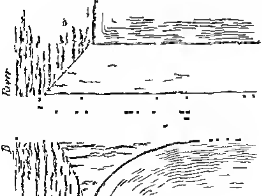


Fig 3
Mode of Securing the flanks of a Dam



J W Lowry sc

John Weale 59 High Holborn 1846

opportunity of arranging what you have to execute under the direction of some general principles.

The principles of defence must be taken into consideration as far as they will apply, and if with a knowledge of these principles an Officer is practically acquainted with the means that are usually employed for strengthening such posts, a very little experience will enable him to arrange his plan, and set his men to work with a confident expectation that in a very few hours he will be able to convert a peaceable domicile by converting it into a respectable fortress.

The objects now under consideration are churches, country houses, factories, prisons, or other substantial buildings; and as there is but little difference in the mode to be pursued for placing any of them in a state of defence, an explanation of the details applied to a single house will perhaps be sufficient to convey an idea on the subject.

What has before been said of the points requiring attention in the selection of a military post will be applicable if a choice is to be made among buildings: thus, a building proper for defensive purposes should possess some or all of the following requisites:

First. It should COMMAND all that surrounds it.

Second. Should be SUBSTANTIAL, and of a nature to furnish materials useful for placing it in a state of defence.

Third. Should be of an EXTENT PROPORTIONED TO THE NUMBER OF DEFENDERS, and only require the TIME AND MEANS which can be devoted to completing it.

Fourth. Should have walls and projections that mutually FLANK each other.

Fifth. Should be DIFFICULT OF ACCESS on the side exposed to attack, and yet have a SAFE RETREAT for the defenders, and

Sixth. Be in a situation proper for fulfilling the object for which the detachment is to be posted.

A church will be found more usually to unite all these good properties than any other building.

It may be remarked, that though good strong walls are an advantage, yet their thickness should be limited to 2 or 3 feet, from the difficulty there would be in piercing loopholes, unless when they are likely to be battered by artillery, in which case the musketry must be confined to the windows, and the more solid the walls are, the better. It should also be remembered that brick houses and walls are preferable, on several accounts, to those built of stone, for when exposed to artillery, a round shot merely makes a small hole in the former, but stone is broken up in large masses, and dangerous splinters fly from it in all directions. It is much easier also to make loopholes through brick work than through masonry. Wooden houses, or those made of plaster, are to be avoided, from the facility with which an enemy can set fire to them, and they are frequently not even musket-proof. Thatched houses are equally objectionable on account of fire, unless there is time to unroof them, and after all it must not be forgotten that earthen works, when exposed to artillery, are to be preferred to houses, so far as affording security to the defenders is concerned. In seeking this security, however, it should be borne in mind that they are not so *defensible*, for troops cannot be run into a house, but they are not exempt from such an intrusion in an earthen work of the nature under discussion. The two together can be made to form a more respectable post than *either* can be made into singly, for the merits of both will be enhanced, and the defects be modified by the union. A building is therefore at all times a capital base to go to work upon. The walls may be partially protected from cannon shot by throwing up earthen parapets round it, and the house may 'reciprocate' by acting the part of a keep, and

afford the garrison a place of refuge in which they may either defend themselves with advantage, or, if it 'suits their book,' resume the offensive, and drive the assailants out again

An Officer will be able to make his selection at first sight, with reference to most of these points, but it requires a little more consideration to determine whether a building and its appliances are convertible into a post, of a size proportioned to the force under his command The average number of men, however, proper for the defence of a house may be roughly estimated on some such data as the following — that in a lower story it might generally be proper to tell off one man for every 4 feet the walls measured round the interior * in the second story one man for every 6 feet, and in an attic or roof one man for every 8 feet For example, if a house of three stories high were found on pacing it to measure 140 feet round the interior walls, the number of men for its defence on the above data would be determined thus

Feet

$\frac{140}{4}$ would give 35, which would be the number of men for the lower story,

$\frac{140}{6}$ would be about 23 men for the second floor;

$\frac{140}{8}$ would be 18 men for the attic,

making a total of 76 men for the three stories, to which about one sixth of the whole, say 14 men, should be added as a reserve, altogether forming a garrison of 90 men If there were out buildings or walls in addition, the number of men required for their defence would be determined in a similar manner by assuming certain data adapted to the circumstances as a guide in the calculation

These numbers are not to be considered *definitive*, but merely to convey an idea on the subject, for if a detachment were much weaker in proportion to the extent a vigorous defence might still be made the force might be concentrated where most required, as it is not a matter of course that a place will be attacked on all sides at once, or if a building were found so large that the disposable force would be too much disseminated, or if there were a want of materials and time for putting the *whole* of it in a state of defence, a *part* of it only might be occupied.

Should there exist any doubt about having sufficient time to complete all that might be wished, it would become matter for consideration what were the points which it would be of the greatest importance to secure first, so as to be in a condition to repel an *immediate* attack, because such points would naturally claim attention to the exclusion of all others

In such a case, it might be well to employ as many men as could work without hindering each other by being too crowded

Firstly To collect materials and barricade the doors and windows on the ground floor, to make loopholes in them, and level any obstruction outside that would give cover to the enemy, or materially facilitate the attack

Secondly To sink ditches opposite the doors on the outside, and arrange loopholes in the windows of the upper story

Thirdly To make loopholes through the walls generally, attending first to the most exposed parts, and to break communications through all the party walls and partitions.

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* Pacing round the outside of the house and making an allowance for the thickness of the walls would be the easiest way of determining the interior dimensions

Fourthly. To place abattis or any feasible obstructions on the outside, and to improve the defence of the post by the construction of tambours, &c.

Fifthly. To place out buildings and garden walls in a state of defence, and establish communications between them. To make arrangements, in the lower story especially, for defending one room or portion after another, so that partial possession only could be obtained on a sudden rush being made. These different works to be undertaken *in the order of their relative importance*, according to circumstances; and after securing the immediate object for which they were designed, they might remain to be improved upon if opportunity offered.

An endeavour will now be made to explain the mode of executing these works in the order in which they are mentioned.

COLLECTING MATERIALS.

The materials that will be found most useful in barricading the passages, doors, and windows, are boxes, casks, cart bodies, bricks, stones, cinders, dung, &c., and timber of any sort that comes to hand: if it cannot be found elsewhere on the premises, the roof and floors must be stripped to furnish what is required.

BARRICADING DOORS.

In the application of these materials, the boxes and casks filled with cinders or dung, and placed against the doors to a height of 6 feet, will prevent their being forced open, and loopholes may be made through the upper portions, which can be rendered musket proof, to protect the men's heads: short lengths of timber piled one upon another to the same height, leaving a space between any two of them in a convenient situation for firing through, and their ends being secured in the side walls of a passage, or propped with upright pieces on the inside, will effect the same object; or a door may be loosely bricked up, leaving loopholes, &c.

If it is probable that artillery will be brought up for knocking away these barricades, and so forcing an entrance, a passage may be partially filled with dung or rubbish to the thickness of 8 or 10 feet, or thick beams of timber may be reared up on the outside of a door, and the interval filled with the same, or with earth, if more convenient.

A small hole, 3 feet square, may be left through an ordinary barricade for keeping up a communication with the exterior; but for effecting a retreat, or making sorties, it will be necessary to make a door musket proof* by nailing on several additional thicknesses of plank, and arrange it so as to open as usual, or to contrive something on the spot which shall equally protect the men when firing through the loopholes, and yet be removeable at pleasure.

BARRICADING WINDOWS.

Windows do not require to be barricaded so strongly as doors, unless from their situation an entrance may easily be effected, or an escalade be attempted. The principal object is to screen and protect the defenders whilst giving their fire; anything, therefore, that will fill up the window to a height of 6 feet from the floor, and that is musket-proof, will answer the purpose. Thus two or three rows of filled sand bags laid in the sill of a window, (fig. 1,) or short lengths of timber, would do; or a carpet, a mattress, or blankets rolled up, would be ready expedients. Loopholes would in all cases be arranged, whatever materials were used. If time presses and windows could not be blocked up, one means of obtaining *partial* security would be to hang a great coat or blanket across the lower part of them as a screen, and make the men fire

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* See article "Barricade," p. 130.

beneath it, kneeling on the floor. The glass should be removed from windows before an attack commences, as it is liable to injure the defenders when broken by musketry

LEVELLING OBSTRUCTIONS OUTSIDE.

Any shrubberies, fences, or out buildings, within musket shot, which would favour an attack by affording cover to an enemy, and allowing him to approach unperceived, it is essential to get rid of as soon as possible The trees should be felled, leaving the stumps of different heights, so as to encumber the ground, and the materials of walls &c must be spread about with the same view, but whatever is convertible for barricades should be carried to the house The thatch from roofs, and any combustibles, should also be removed or destroyed.

DITCHES IN FRONT OF THE DOORS, &c

As a means of preventing a door being forced, a ditch may be dug in front of it, about 7 feet wide and 5 feet deep such a ditch also is necessary in front of the lower windows, if the loopholes cannot be conveniently made high enough from the outside to prevent an enemy reaching them, as would be done in managing matters for the defence of walls These partial ditches may afterwards be converted into a continued ditch all round a house if opportunity offers, as it would contribute to the defence of the post The floors may also be taken up on the inside, opposite the doors or windows open to attack.

LOOPHOLES

1 If the walls are not too thick, they may be pierced for loopholes, at every 3 feet in the spaces between the windows, &c (Fig 1) These loopholes can be knocked through with a crow bar, or even a pickaxe; they should be just such a size as to enable you to see your enemies without being seen by them

Two tiers of these loopholes may be made if opportunity offers, and a temporary scaffolding of furniture benches, casks, or ladders, &c erected for firing from the upper ones on the lower story a row of loopholes may be made close to the ground. The floor must, in this case, be partly removed, and a small excavation made between the beams for the convenience of making use of them. Just under the eaves of a roof there is generally a place where loopholes can be made with great facility, and a tile or slate knocked out here and there with a musket will give other openings from which an assailant may be well plied as he comes up.

COMMUNICATIONS

A clear communication must be made round the whole interior of the building by breaking through all partitions that interfere with it, and for the same purpose, if [illegible] be opened so as to have free [illegible]

also be made in the upper floors to fire on the assailants, if they force [illegible] and arrangements made for blocking up the staircases, with some such expedients as a tree, prepared in the same manner as for an abattis, or by having a rough palisade gate placed across Balconies may be covered or filled up in front with timber or sand bags and made use of to fire from downwards * Fig 2 (See Abattis, p. 32)

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* See article "Machicoulis"

ABATTIS

The partial levelling of any object on the outside, that would give concealment to an enemy, and favour an attack, is supposed to have been already attended to; but if time admits, after the loopholes, &c are completed, this system must be extended and perfected, and the formation of a more regular abattis should be commenced, and any other obstruction added that opportunity permits The best distance for such obstructions, if they are continuous and cannot be turned, is within 20 or 30 yards of a work, or even less, so that every shot may tell whilst the assailants are detained in forcing a passage through them

TAMBOURS

If the building that has been selected has no porches, wings, or projecting portions from which flank defence can be obtained, it will be advisable to construct something of a temporary nature to afford it

Stockade work offers a ready means of effecting this object; it may be disposed in the form of a triangle, projecting 8 or 10 feet in front of a door or window (fig 4), planted in the manner and with the precautions of having the loopholes high enough A small hole should be left in the barricade of the door or window to communicate with the interior Three or four loopholes on each face of the projection, cut between the timbers, will be found very useful in the defence These contrivances are usually termed tambours, and if constructed at the angle of a building, will flank two sides of it (Fig 3)

OUT BUILDINGS AND WALLS.

When the defences of the main building are in a state of forwardness, any out-buildings or walls which have been found too solid to be levelled at the moment, or which have been preserved for the chance of having time to fortify them, and thus to increase the strength of the post, must be looked to They may be placed in a state of defence by the means already described and separate communications should be established between them and the principal building by a trench, or a line of stockade-work, and by breaking through the walls when necessary In this way a post may be enlarged in any required proportion, by turning all objects that present themselves, such as out buildings, sheds, walls, hedges, ponds, &c to the best account; first taking the precaution to secure what is absolutely necessary for *immediate* protection, and for placing it in a state to be defended on the shortest notice

An exterior wall or fence, tolerably close to a house and parallel to it, may be retained for the purposes of defence, without the danger of affording cover, and thus facilitating an attack, by throwing up a slope of earth on the outside of it, or planting an abattis in the same situation (fig 5) An enemy would thus remain completely exposed, and it would be worse than useless to him

If a post of the description under consideration were composed of two or more buildings, and it were to be left to itself, and were open to attack on all sides the stockades or trenches, forming the communications between them, would obviously require to be so arranged as to afford cover, and the means of resistance *on both sides* This would be effected by merely making them *double*, as shewn in figs. 5 and 7, but for greater security, the exterior of such communications should be laid under fire from the buildings at their extremities

In arranging the defences of such posts, it is an essential point to make each portion of them so far Independent of the others, that if any one part, such as a building for instance, be taken, it shall not compromise the safety of the remainder, or materially impair the defence they will make by themselves, so that whilst free communications are essential in most cases to a vigorous defence, the means must be

spring and basis of all defensive measures;—the latter, by judicious internal arrangements, in occupying the different works to advantage,—posting the pickets, reserve, and support, so as to enable them to perform their respective duties with decision and effect,—appointing convenient situations for assembly on the first alarm,—judiciously quartering the troops, &c.

In making these preliminary arrangements for the defence, a Commander would never lose sight of the great importance of getting every man to his post in the least possible time; and when he had ascertained by false alarms, or other means, what he could trust to in that respect, his next care would be to take such steps as would at least insure sufficient notice of the approach of an enemy, to enable him to dispose his force without hurry, for giving him a warm reception. For instance, it might require half an hour to do this leisurely, and he would therefore, on this supposition, so distribute his outposts, &c as to feel secure of having the time to himself, after the first alarm was given, and before an attack could possibly be made. If he fails in having sufficient notice to do this, it is ten to one he is beat, for the best measures will be of little avail if they cannot be carried into full effect. It will be needless to harass troops by multiplying outposts so as to secure earlier intelligence than is required; but still it will be an error on the right side to take twenty precautions too many, rather than to neglect a single one. In making his dispositions, therefore, he would endeavour to steer a middle course between two extremes; on the one hand, if troops are overworked in preparing for an attack, and guarding against a surprise, they are thrown out of condition for resisting it when made,—on the other, if all due precautions are not taken for first strengthening the post, and then guarding it, they risk the loss of all their labour in being exposed to a sudden attack, at a time when they are in no form for opposing adequate resistance.

In the distribution of the defenders, too, there are extremes to be avoided: for instance,—if all the parapets and works are manned without regard to the requisite force which should be in reserve for giving support, though the greater number formed for opposing a first shock might lessen the danger of being upset by it, yet a line cannot stand up for any length of time against a column that from circumstances can be brought into contact with it; and when once it is forced at two or three points, the game is pretty nearly up, unless there is something fresh to go to work with. The opposite defect would be in giving undue strength to the reserve at the expense of the parapets, which, from being feebly defended, would not then offer the resistance they ought to oppose. Another such a passage to steer between a Scylla and a Charybdis, and another to that, might be added if these little principles were pursued further; but we may safely trust to common sense suggesting more on the spot under the ever varying circumstances that arise on service, than the *memory* can supply,—provided that the *simple principles* and *essentials* of the subject have made that impression on the mind which has secured their *saliency*. *If they are at home* when wanted, there is a natural tendency in minor matters to fall into their places and come right of themselves, and we will therefore leave the rough outline as it is.

The proportion of the disposable force to be retained in hand for the reserve would be governed by circumstances, depending on the number of assailable points, and the calls that might be expected to be made upon it for assistance—perhaps from one fourth to one sixth of the whole would not be far off the mark. The remainder would be subdivided for a variety of duties, such as a garrison for each separate house that had been strengthened, and one for the keep,—*defenders for* the intrenchments, breastworks, and stockades,—pickets, guards, &c.

A *strong reserve* picket should be mounted at the rallying point of the reserve,

which should be near the centre of the village in some open place having free communication to all the defences. Another picquet would be in the keep, and, according to circumstances, others might be required at different points. An outlying picquet or two would be equally necessary in commanding avenues beyond the works, and a communication between all of them should be kept up by a chain of sentries or frequent patrolling. If cavalry form part of the force, some of the outpost duties during the day might be allotted to them, as they can patrol to a greater distance to see what is going on, and also at [illegible]. In the evening they would be replaced by infantry; but if the picquets were distant a few cavalry patrols should be attached, to assist in keeping up the communication, or to gallop in with intelligence. The picquets would of course be accoutred and ready to stand to their arms at an instant's warning, and those for the immediate defence of any distinct portion of the works, such as intrenchments or barricades, should either be hutted or encamped close to the spot, or lodged in the nearest building, if one were found conveniently situated for the purpose; this is essential, for an enemy, if unopposed for even a few minutes, will surmount without difficulty such obstacles as are usually met with in the temporary works that have been treated of.

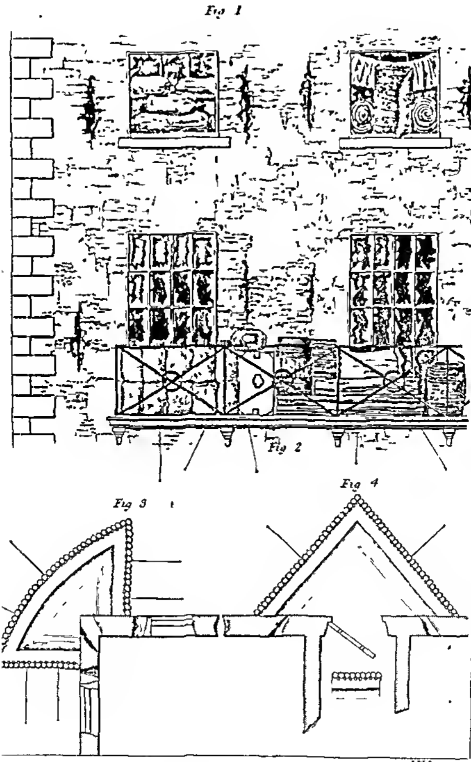
Every Commanding Officer of a regiment should have a steady non-commissioned officer of each company to sleep within hail of him every night,—one who is perfectly acquainted with the quarters of every officer and non-commissioned officer in his company; so that at any instant orders might be conveyed with the utmost promptitude to any part of the corps, however much it might be distributed. And on the same principle every Officer in command of a company which was detached should retain the means of readily communicating orders.

The support, too, should be close at hand in the nearest houses, and they should have a hint that there is no necessity for being *shy* about breaking out fresh doors or doing any thing else that may make their communications more *direct* or *convenient*. On these occasions it should always be borne in mind that a *straight* road is the shortest, and if it is a *wide* one, so much the better, provided it is not one that an enemy can avail himself of. In more permanent works there is not this extreme necessity for having the *defenders* of them as it were constantly under arms to repel an attack; for if a sharp look-out is kept, the obstacles presented by deep and wide ditches, stout palisading, &c. will of themselves consume as much time of the assailants as will enable the *defenders* to repair to their posts, even if it was at rather shorter notice than might be agreeable; but here it is obviously a matter of paramount necessity.

These precautions having been taken for guarding a village against a surprise and for immediate defence, and the remainder of the force being apportioned according to circumstances for occupying the different works and buildings, it would become an [illegible]

[illegible] by 2, when the night is dark and tempestuous, as that is the 'time o' day' for a surprise. During the winter too, when men cannot be so much exposed under arms, and human nature is prone to look for scraps of creature comfort under the lee of anything that will protect them from a keen frost, [illegible] the attention [illegible]

ca[illegible]



J W Lowry sc

John Weale 59 High Holborn 1846

Fig 6
Elevation of Fig 7

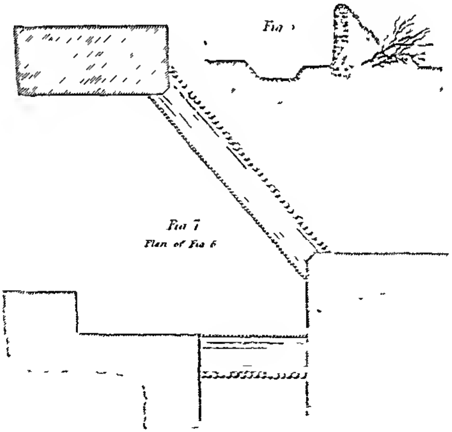
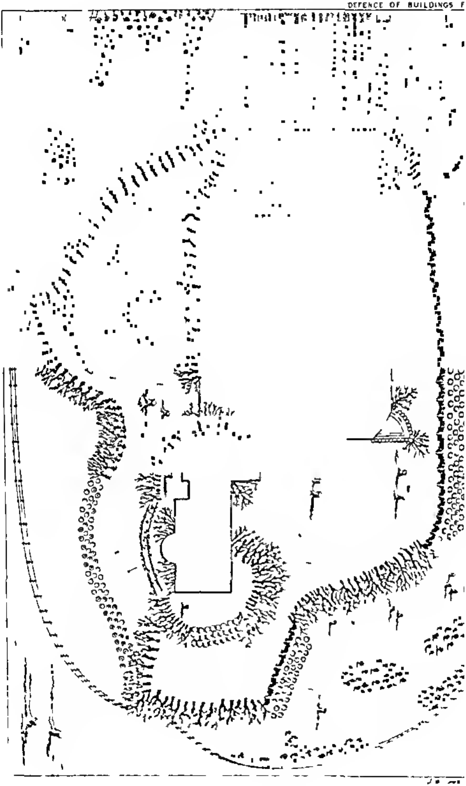


Fig [illegible]

Fig 7
Plan of Fig 6



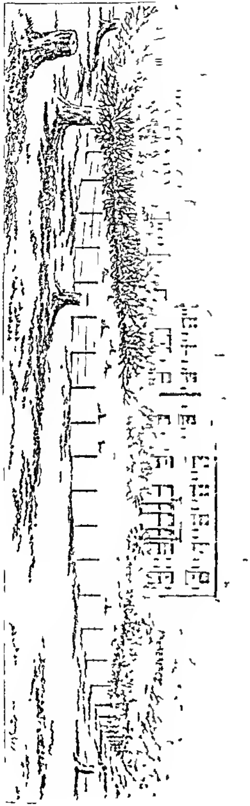
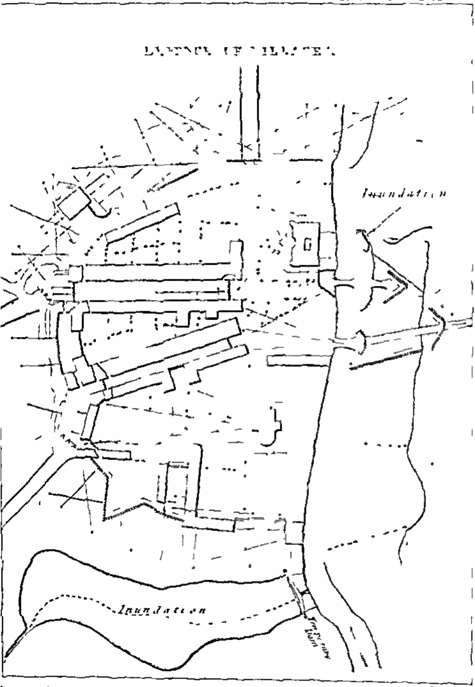


Fig. 9


Inundation
Inundation

It is stated that villages may be intrenched under different circumstances, the chief of which are,—whether the force defending them is to be supported from the flanks or rear during an attack, or whether the post is to be considered independent of other operations, and therefore to be defended to the last by the troops thrown into it. In the former case, the communication with the rear and on the flanks, and the means of holding the ground by a succession of defensive lines, would have been previously arranged, which would give the supporting troops the opportunity of acting with effect, whilst the original force was re-forming In the latter, a keep would have been indispensable, and the reserve would protect the retreat of the different detachments from the more open works of the contour into this stronghold

Much however would have to be done on both sides before a retreat to the keep or anywhere else would be thought of; and as *much* cannot be done without an expenditure of *time* to do it in, the object of defending the post at all might still be fulfilled, whatever the issue of the combat might be, for in all combined operations we may say with a French author, '*Que le but de l'art défensif est de gagner du temps.*'

More important ends than saving a little time are however frequently gained at the trifling cost of taking the trouble to strengthen a post, for the determined attitude which all the troops affected by the operation are enabled to assume, from feeling a proper confidence in the resources which may be acquired by these means, either for defending themselves or for repelling an attack, may have the effect of warding off a threatened blow altogether There is certainly something in the bristling look of an abattis, and the mischievous aspect of a wall or building full of loopholes, enlivened by an occasional appearance of a cap or a bayonet, that is more calculated to induce a little reflection than when dangers are more obviously inviting

DEFENSIVE ELEMENTS* obtained from the local vegetation of every climate scientific plantation being inexpensive, easily kept in repair, stronger with age, and then less destructible by hostile missiles than regular revetted works

"Nervii quo . . . . impedirent, teneris arboribus incisis atque inflexis, crebrisque in latitudinem ramis enatis et rubis sentibusque interjectis, effecerant ut instar *muri* hæ sepes munimenta præberent Quo non modo *non intrari* sed ne perspici quidem possit"—*Cæs de B G* lib ii

Officers charged with the defence of a frontier, an island, or a colony, are often unable to carry their projects of fortification into effect on account of the enormous expense they demand when the system is sufficiently enlarged to be really effective Moreover, Engineers find themselves posted in regions where the materials required for the due execution of their purposes are rare, expensive, or inaccessible and where the scientific systems, primarily invented for the conditions of European warfare alone, are little applicable, or if they are within this sphere, they may have to submit projects, which, however much they may be appreciated for their importance and utility, are nevertheless inadmissible, because under existing systems of national defence the resources of a kingdom are often scarcely, or not at all, adequate to the expenditure of construction and repairs.

It becomes, therefore, desirable with the departments in charge of this great branch of the Service to devise means both on the great and on the smaller scales for home and for distant regions, which, while they maintain the most approved

* By Colonel Hamilton Smith K. H.

principles of permanent defence in their integrity, render them nevertheless available in all places, by such modifications as the nature of the soil or the climate will admit, and the elements accessible for the purpose offer, for employment. In all climates, the resources of mountain, hill, rock, ravine, sea, lakes, rivers, and marshes occur, but the best systematic methods for adapting them to defence are not the object of these remarks they are thoroughly understood by the scientific corps in every Service Now the use of a method applicable to permanent fortification,—one entailing but a comparatively trifling expense,—kept up in a perfect condition with only the proper supervision of a few well instructed men, and withal, one under such supervision becoming stronger and stronger with the increase of years,—may be found in the botanical resources of every region more or less fit for the purpose, and it will be proper, at convenient opportunities, to study in each locality what plants should be selected for the differences of soil where they may be wanted.

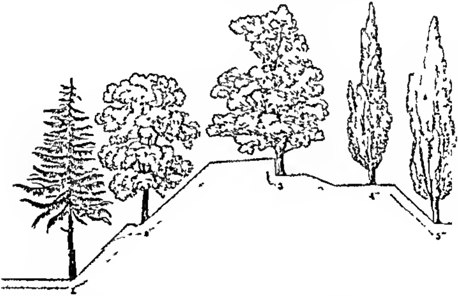
That the idea of systematic defensive plantation is not new, may be gathered from the motto at the head of this article, taken from Cæsar, and also from our wars in the mountainous parts of India. The proposition therefore is urged mostly on the ground of the vast resources it creates for an Engineer, endowed with a suggestive mind, to adapt available botanical means to the wants and conditions of the problems he has practically to solve.

The qualities of trees and plants best adapted for the formation of living, or at least vegetating ramparts, are necessarily,—1st, those which will flourish best in the closest practicable linear juxtaposition, 2nd, those that grow straightest, 3rd, those that have the hardest wood, and, 4th, those that strike the deepest roots In the tropics alone the Engineer can find evergreen trees with spinous bark, and for covering the front of the approaches, impeding ascent on the rampart, intersecting communications, lining dry ditches, and, above all, rendering escalades and surprises impracticable, the tropics and hot climates again are best provided, though Europe, and even the North, are not deficient in valuable means for effecting the same purpose, provided we remain satisfied with several of the most essential qualities, for all united can seldom, if ever, be found in one species of plant

In northern and middle Europe the species best adapted are, first, several of the Coniferæ, such as the Swiss pines, the larch, the spruce and juniper pine, the Scots and silver firs, Araucarias and New Zealand pines, &c, then beech trees and Lombardy poplar Where it is desirable to have a rapid growth, the same Lombardy and the small leaved black poplar, but in the South by far the best is the cypress Within and on the borders of the tropics, palms of various genera are decidedly the best, because there are species that thrive in salt water, others in marshes, and many on the uplands and even on high mountains Though they have very little depth of root, they bear very approximate planting, admit easily of palisades between them, and offer the most enduring resistance to cannon shot. Research and experience will most assuredly, discover many other trees and improved modes of applying them, but in a general view, where reasoning from a few known facts, we may draw certain inferences to a given extent Thus it may be asserted with perfect security in truth, that trees in general are but little shattered by cannon shot, as from personal examination was proved in the parks and plantations of Dresden, in the great avenues along the Pleisse on the south of Leipsig, and in the gardens of M Reichenbach, both localities long exposed to most terrific cannonades and unceasing musket fire,* and in 1830 the park of Brussels offered the same results

With regard to the trunks of palm trees, the attack of Mudfort Island, near Philadelphia, in 1777, is a proof that cannon shot have inadequate effect upon them. Cocoa trees and other palms will flourish at 4½ feet distance from each other. We have examined a row of cypresses near Marseilles, all from 75 to 80 feet in height, and above 2 feet in diameter, yet not more than 5 feet from each other. In the gardens of M. Reichenbach, already mentioned, several avenues about 16 feet broad were planted with Swiss pines, in some places so closely that it was difficult to pass between them, yet the trees were upwards of 40 feet high, with trunks 18 inches or more in diameter, and literally having the bark on one side riddled with innumerable musket shots fired into them at the battle of Leipsig, seven years before we examined them. At Neuwied on the Rhine, the *allée* or avenue to the back of the prince's palace is planted with four rows of Lombardy poplars, many of which are estimated at above 100 feet in height, and the trunks at base nearly 5 feet in diameter: the avenue is broad, but the two rows on each side are scarcely 10 feet from each other, or lengthwise from centre to centre of each tree.

Now, supposing a great front of defence, such as a permanently fortified camp destined to hold up the ultimate vitality of a State, be the object under consideration,—and without adverting to the particular system of fortification, as regards the projection the Government may sanction,—we confine our view for the moment to the mere profiles of construction intended for the curtains and allowing the talus to be about forty five degrees, in order to give greater stability to the trees, we commence near the foot, at a proper elevation above the water, if the ditch be wet, or at the



foot itself if it be dry: we plant thereon a row of the class of forest trees appropriate to the nature of the circumstances of the works as well as of climate and soil, a second upon the berm, a third forward on the banquette of the parapet, which being the most important should be entirely composed of the best-conditioned plants: we then proceed with a fourth at the edge of the terreplein, and a fifth within the polygon at the foot of the inner slope of the rampart. We shall have

principles of permanent defence in their integrity, render them nevertheless available in all places, by such modifications as the nature of the soil or the climate will admit, and the elements accessible for the purpose offer, for employment. In all climates, the resources of mountain, hill, rock, ravine, sea, lakes, rivers, and marshes occur, but the best systematic methods for adapting them to defence are not the object of these remarks they are thoroughly understood by the scientific corps in every Service Now the use of a method applicable to permanent fortification,—one entailing but a comparatively trifling expense,—kept up in a *perfect condition* with only the proper supervision of a few well instructed men, and withal, one under such supervision becoming stronger and stronger with the increase of years,—may be found in the botanical resources of every region more or less fit for the purpose, and it will be proper, at convenient opportunities, to study in each locality what plants should be selected for the differences of soil where they may be wanted.

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* It was in this garden Prince Poniatowski perished and nine Polish battalions with four Generals surrendered after a most determined defence for they left 500 dead on the spot *The close set trees in the walks alone rendered the protracted defence possible*

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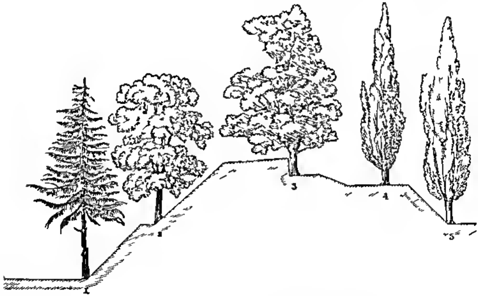

foot itself, if it be dry we plant thereon a row of the class of forest trees appropriate to the nature of the circumstances of the works as well as of climate and soil, a second upon the berm, a third forward on the banquette of the parapet, which being the most important, should be entirely composed of the best conditioned plants we then proceed with a fourth at the edge of the terreplein, and a fifth within the polygon at the foot of the inner slope of the rampart We shall have

principles of permanent defence in their integrity, render them nevertheless available in all places, by such modifications as the nature of the soil or the climate will admit, and the elements accessible for the purpose offer, for employment In all climates, the resources of mountain, hill, rock, ravine, sea, lakes, rivers, and marshes occur, but the best systematic methods for adapting them to defence are not the object of these remarks they are thoroughly understood by the scientific corps in every Service Now the use of a method applicable to permanent fortification,—one entailing but a comparatively trifling expense,—kept up in a perfect condition with *only* the proper supervision of a few well instructed men, and withal, one under such supervision becoming stronger and stronger with the increase of years,—may be found in the botanical resources of every region more or less fit for the purpose, and it will be proper, at convenient opportunities, to study in each locality what plants should be selected for the differences of soil where they may be wanted

That the idea of systematic defensive plantation is not new, may be gathered from the motto at the head of this article, taken from Cæsar, and also from our wars in the mountainous parts of India The proposition therefore is urged mostly on the ground of the vast resources it creates for an Engineer, endowed with a suggestive mind, to adapt available botanical means to the wants and conditions of the problems he has practically to solve.

The qualities of trees and plants best adapted for the formation of living, or at least vegetating ramparts, are necessarily,—1st, those which will flourish best in the closest practicable linear juxtaposition, 2nd, those that grow straightest, 3rd, those that have the hardest wood, and, 4th, those that strike the deepest roots. In the tropics alone the Engineer can find evergreen trees with spinous bark, and for covering the front of the approaches, impeding ascent on the rampart, intersecting communications, lining dry ditches, and, above all, rendering escalades and surprises impracticable, the tropics and hot climates again are best provided, though Europe, and even the North, are not deficient in valuable means for effecting the same purpose, provided we remain satisfied with several of the most essential qualities, for all united can seldom, if ever, be found in one species of plant

In northern and middle Europe the species best adapted are, first, several of the Coniferæ, such as the Swiss pines, the larch, the spruce and juniper pine, the Scots and silver firs, Araucarias and New Zealand pines, &c.; then beech trees and Lombardy poplar Where it is desirable to have a rapid growth, the same *Lombardy* and the small-leaved black poplar, but in the South by far the best is the cypress. *Within and on the borders of the tropics, palms of various genera are decidedly the* best, because there are species that thrive in salt water, others in marshes, and many on the uplands and even on high mountains Though they have very little depth of root, they bear very approximate planting admit easily of palisades between them, and offer the most enduring resistance to cannon shot Research and experience will, most assuredly, discover many other trees and improved modes of applying them, but in a general view, where reasoning from a few known facts, we may draw certain inferences to a given extent Thus it may be asserted with perfect security in truth, that trees in general are but little shattered by cannon shot, as from personal examination was proved in the parks and plantations of Dresden, in the great avenues along the Pleisse on the south of Leipsig, and in the gardens of M Reichenbach, both localities long exposed to most terrific cannonades and un ceasing musket fire,* and in 1830 the park of Brussels offered the same results

With regard to the trunks of palm trees, the attack of Mudfort Island near Philadelphia, in 1777, is a proof that cannon shot have inadequate effect upon them. Cocoa trees and other palms will flourish at 4½ feet distance from each other. We have examined a row of cypresses near Marseilles, all from 75 to 80 feet in height, and above 2 feet in diameter, yet not more than 5 feet from each other. In the gardens of M. Reichenbach, already mentioned, several avenues about 16 feet broad were planted with Swiss pines in some places so closely that it was difficult to pass between them, yet the trees were upwards of 40 feet high, with trunks 18 inches or more in diameter, and literally having the bark on one side riddled with innumerable musket-shots fired into them at the battle of Leipsig, seven years before we examined them. At Neuwied on the Rhine, the *allée* or avenue to the back of the prince's palace is planted with four rows of Lombardy poplars, many of which are estimated at above 100 feet in height, and the trunks at base nearly 5 feet in diameter; the avenue is broad, but the two rows on each side are scarcely 10 feet from each other, or lengthwise from centre to centre of each tree.

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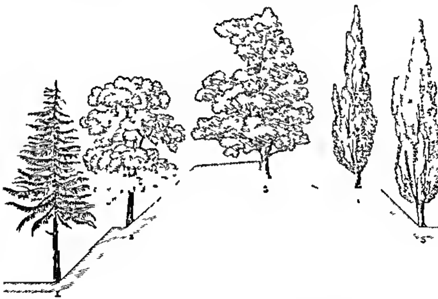

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in a few years five rows of trees capable of material use in defence, provided the plants are laterally cleared of branches* as they grow up, and those to the front *and rear* alone preserved until above 25 feet from the ground No 1, the *foremost* in the *fossé* when a state of siege or attack is apprehended, will be cut down along with that on the berm, No 2, brought within and employed with No 5 *at the foot of* the terreplein, to convert into *palanka*† palisades, in order to fill up the intervals between the living trees of the parapet, to construct *blindages*, bomb proofs, *frases*, and defences for the caponières in the ditch On the edge of the counterscarp, as also on the crest of the glacis, another row may be planted, and from thence outwards, in quincunx, trees remarkable for striking deep tap-roots, such as Turkey oak, Valonia oak, Ilex, larch, &c. In hot climates, palm trees, cocoa-trees, date trees, fan palms, arecas, &c; some, like the cocoa, growing in salt water, all which, being cut down at the moment before stated, will suffice to palisade the banquette of the glacis, intersect the external roads for rounds, make gates, and, *where necessary*, fraise the rampart securely, by connecting the fraises with the stumps of the removed trees.‡

The pine, larch, or fir species, may be planted at 3 *feet* apart, *thinning them out* eventually is objectionable

The *enemy* cannot see what passes within the lines, nor gain much information, *nor attempt* an escalade by surprise, much *less venture* to *storm* works which he cannot previously dismantle with his cannon By palanka palisades we understand such as could be made from young trees in the rough, standing above ground irregularly from 14 to 18 *feet* in height where unsupported by living trees, they should be completed like a common stockade climbing over them need not be mentioned as practicable so long as any resistance is *offered even* by the worst disciplined troops In confirmation of this observation, it may be stated that the Austrians and Russians were in general successful in storming French redoubts protected by ordinary palisades, but that they never ventured to attack the palanka defended redoubts at Dresden, nor did General Maison attempt those of the Saxons covering the gates of Tournay, in the beginning of 1814, they being similarly formed

On the crest of the glacis and the immediate slope *before* it, as also to cover caponières, hedges of holly (Ilex aquifolium) will make a very difficult obstacle; and in sandy soils the common *furze* (Ulex Europeus), when occasionally shorn and trimmed, is likewise convertible to impenetrable hindrances, and where and when required, both may be cut *down* low without losing the defensive property. As from the palisades the defensive troops behind the glacis *can* view through the lower *part of the hedge of the champaign* country, and *can reach* through with the muzzles of their muskets, they can *obstinately* chicane the outposts, notwithstanding any tirailleur *force* that may be sent against them, or the grape shot that may be showered in *their direction*, because the assailant must be wholly exposed, while the defendants are entirely concealed. Where neither holly nor furze can be procured, yew hedges (Taxus baccata) are likewise very difficult to force, and hornbeam-*tree* (Carpinus betulus) and *blackthorn* (*Prunus* spinosa) *may* be made to answer in Europe All these plants require only in the first instance proper selection and preparation of the soil, and subsequently careful trimming and watching §

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* Care must be taken never to lop the branches within one foot of the trunk as when cut too close decay frequently commences at those points.—*Ed*

† See Note p ∗∗

‡ *The impediments to sapping caused by the roots of trees are well known*

§ There are many other available species and some *foreign* that will thrive exceedingly well in Europe even far to the north, such as the *Carpinus Virginiana* a quick growing hard tall and very handsome tree and the Jakoom-tree in the east makes excellent *defensive hedges*.

Such a system would demand in time of peace only a small portion of veterans to guard the works, and among them a certain number trained to trimming and preserving the plantations. When peril threatens, a general requisition of handicraftsmen would in a short time prepare the whole for defence; the resources of the country would take safe shelter behind the lines; and under the command of a few experienced Officers, even a half trained volunteer population, a landwehr, or a militia, would maintain the position, provided an adequate body of artillery were with it. With the new dangers steam-boat warfare may bring forth, when almost every coast may be threatened with sudden and serious invasion, certain points may be deemed to require such positions of refuge, fit for concentration, more than formerly.

On a minor scale, and of less importance, are the defences required in the colonial and particularly tropical possessions of the nation. Excepting where the French have built and maintain at a vast expense their citadel forts, the extra European systems of fortification are absolutely insufficient. The ardent sun, violent rains, and frequent earthquakes, together with the economical indifference of the colonial legislatures, cause in particular all English defences to fall to ruin. Instancing Jamaica, the two principal fortified points, Port Royal and Fort Augusta, are (or at least during the wars of the French Revolution were) totally indefensible: both their fronts of defence were of masonry, but cracked by earthquakes, undermined by the sea, and filled with sand: the first passable even without a scaling ladder, and the second without ditch, drawbridge, gate, outwork, or glacis. In the one, no guns mounted or fit for service; in the other, most of them taken off the rampart, and the rest drawn back on account of the insecurity of the wall. All the other fortifications in the island were still in a worse condition; no gun-carriages fit for service, and many guns unfit to be loaded.

For the defence of all these places positive means exist in the tropics. By the encouragement of the growth of cocoa and mountain cabbage trees, by the introduction from the Continent of numerous other species of palm, all the sandy and saline lands on the sea shore may be beneficially and cheaply planted, and in many places they might be arranged in the manner before described so as to form fronts of defence, which, when necessary, would require only the cutting down those that grew beyond the sphere of action, and using them as palisades, &c. Dear bought experience has taught us the formidable nature of bamboo stockades and bound hedges; it suggests similarly that the bamboo should be encouraged in the West India islands, where we have seen clumps in luxuriant growth reaching to 60 feet in height, both on the plains and in the mountains. Both these vegetable families of plants thrive in poor as well as deep soils, and for outworks the Euphorbiæ, Agaves, Cactus opuntium or Echino cactus, Cactus Ficus Indicus, the aloes, and many other thorny productions, require only the care of protection to be made formidable for defensive purposes.

In Jamaica, during the martial law of 1805, it was exemplified what could be done with the botanical resources for the defence of the forts so defectively constructed as above shewn. Representations from the island Engineer to the island Legislature, recommending a very considerable increase of cocoa trees, by planting the nuts within the fences of the '*pens*,' (country residences in the plain of Liguana) and bamboo on the rocky hills, had indeed been received with approbation, but were not put in execution.

But Fort Nugent, at the head of Kingston Harbour, requiring to be placed in a state of defence, advantage was taken of the momentary alarm to cover the front of the whole position in three successive belts, each 9 feet in width, with close set plants of the Cactus (opuntium) undecimalis, a succulent plant growing abundantly on the spot, and although at first military men thought the element employed of little or no defensive value, as the work increased their opinions changed, and some

years after, when the late General Sir Charles Shipley visited the ground on his tour of inspection, he expressed his unqualified approbation of the use of the plant and the method pursued, although from the short duration of military law the whole system had not been completed. The Opuntium undecimalis was introduced from the Spanish Main, and in Peru grows to 25 feet, and branches out In Jamaica it generally forms but one upright unbranched stake, about 7 inches in diameter, having eleven ridges and as many right-angled furrows. Upon the ridges are grown burrs or tufts of siliceous spines exceedingly strong and sharp, three or four of each burr being from one to one and a half inch in length. They stand about 3 inches apart, but each alternate ridge has them on the inter mediate distance, so that a human finger can scarcely touch the smooth green rind without being painfully wounded. Set in juxtaposition and tem porarily kept in line by stakes and poles they form a close hedge, impenetrable even to a rat Musket and cannon-balls make mere holes through them. Being succulent, they cannot be hurnt, and when cut down they are still impassable, since the thorny spines strike through a boot sole and the wound is almost invariably fatal, by producing teta nus or lock jaw Such was the case with the only three negro pioneers who, notwithstanding the care taken by them to move and set up the plants with long wooden pitchforks, were pricked in the feet and died. Hedges thus set up 9 feet asunder the intermediate space was planted with *lower choppings*, and *nearly* all *grew* in the dry sand without further trouble than taking the precaution to have each section or cutting seared by exposure to the air for a few days: this should be done in the shade and last about twenty to twenty-five days before setting The hedge pieces were 3 feet long giving little more than two above ground,

Cactus undecimalis, now probably Echino cactus undecimalis.

APPENDIX

EXPERIMENTS ON THE COMPARATIVE AFFECT OF RIFLE AND MUSKETRY FIRE ON DIFFERENT COLOURS

Parkhurst Barracks, Isle of Wight, 1800

Since the decline of defensive armour, the military costume of civilized nations has gradually become, from feudal and heraldic, either national or governmental in all the organized armies of the world While plate armour was still worn by certain portions of the troops, and generally by the officers, buff or stag skins was the common dress beneath it, and armies were deemed to be sufficiently distinguished from each other by some trifling cross or badge on their ensigns, and by the colour of the scarfs, arm bands, and feathers As the inconvenience of raising military forces on the temporary feudal plan began to be felt more and more there arose a fashion of substituting instead the system of the Italian Condottieri, which permitted individuals of martial reputation to raise, on their private responsibility, bands of various strength, by capitulation or agreement with the State, and to conduct a war for a given number of months or any other stipulated period These conductors or generals, by subordinate indentures, gave commissions to other adventurers, who raised companies and thus became captains who not only commanded but clothed and accoutred them according to their own fancies or heraldic pretensions, and as each company had its ensign, that word became synonymous with it in the North of Europe, where enseignee, ancient, fenlein, or vaendel, were their constant denominations, till the necessity was felt of marshalling the infantry into more equally divided bodies, increasing from the squad to the company, the battalion, or tersa, up to the regiment, which occasionally reckoned four, six, or more of them and therefore amounted to what we now would denominate a brigade, or even a division It was then the fantastic liveries of the ensign bands or companies were laid aside, and uniforms of the same colour were furnished to a whole regiment We hear in the Swedish wars of yellow, blue, and other regiments, and in the trained bands of London, in 1641–1645, we find red, white, yellow, blue green and orange regiments, but it seems that, in England at least, those denominations referred them already solely to the colour of the ensigns not of the regimental uniforms, which under the last Stuarts, were already red with slight exceptions In France and Austria, white had become the predominant uniform of the armies, whilst in Holland and soon after in Prussia, blue was assumed, and then Russia made green the national military colour

Under general circumstances and in battles, when the distance, the smoke of cannon and musketry, partially, at least, concealed contending armies from each other, glaring uniforms may not have caused serious bloodshed, but in the later wars, and the mode of engaging introduced during the French Revolution where the rifle service is greatly increased, and clouds of skirmishing light infantry cover the front of their forces so far in advance as to be checked only by similar combatants pushed forward by the opposing army, the fire of both parties is commonly guided by individual aim, and good marksmen make considerable havoc. The colour of the uniform becomes therefore a question of importance particularly where it is of so distinct a nature as to offer a clear object to the marksman Observation teaches military uniforms to fade from the eye, in proportion as they are neutralized, from red, the most conspicuous, to earthen brown and neutral greys. To the marksmen, white enlarges the object and is so far deceptive, blue reduces the real magnitude, black and dark green assimilate with blue, and light green has a tendency to appear neutral. The relative distinctiveness of these colours was readily ascertained by the normal

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Cactus undecimalis now probably Echinocactus undecimalis

Such is the theory and the limited practice hitherto given of a system of defence by means of the living vegetable productions of the climate where it may be put in execution.

50 If to a blockade the enemy should join a bombardment, the precautions recommended in the preceding paragraph against fire, and for the security of the provisions and ammunition, ought to be made use of. As to the defence in these two cases, it should be external

OF SIEGES, OR REGULAR ATTACKS —FIRST HEAD

51 *From the Period of Investment to the Opening of the Trenches —Lines of Circumvallation, Countervallation, &c*—The presence of an enemy's army within three days' march of a fortress places it in a state of siege The Governor being previously informed of the projects of the enemy, ought to have everything prepared for resisting a regular attack as long as possible

52 As soon as the enemy approaches to invest the place, the Governor finishes his first preparations with all possible activity, he occupies such advanced posts as may have their communications with the fortress secure, he sends patrols in every direction to get information of the enemy's movements, and to find out, as well as they can, his force, his projects, and his means of executing them

53 The investment being effected, the enemy's camp will be drawn on the plan of the place, according to which the Governor, in concert with the Commanding Officers of Artillery and Engineers, will regulate his arrangements for the defence in proportion to the enemy's progress

54 If the garrison be strong some sorties may be hazarded, but it is seldom that sorties at such a distance succeed, unless it be in consequence of the fault of the besiegers in neglecting the ordinary precautions They are besides very fatiguing for the garrison, which it is more advantageous to employ in executing the pressing works always required in a defence

55 At night he will send out small parties in opposite directions, who will creep along taking advantage of banks or uneven ground, and proceed in silence as far in advance as possible, then, lying flat on the ground, they will listen with attention to the smallest noise, they will afterwards retire on the fortress in extended but connected order, to try to surprise Officers who may be out to reconnoitre the place These parties must agree on a signal that they may know each other

56 In the first moments the Governor may employ his good marksmen advantageously* Wall pieces should be placed on the most elevated situations, and he should mix some of the marksmen with the parties sent outside the place, with orders to fire on those who may be attempting to reconnoitre the fortress

57. It is at nightfall that these marksmen, &c ought to watch with the greatest attention, that being the period for reconnoitring tracing, and pushing forward the attacks

SECOND HEAD

58 *From the Opening of the Trenches to the Crowning of the Covered way* —As soon as it is known in what direction the enemy is opening the trenches, the Governor should cause embrasures to be opened, and platforms to be laid for the guns, double rows of palisades to be planted in the covered way, useful temporary works of fortification to be made, such as fleches at the foot of the salient angles of the glacis These fleches, made capable of resisting a coup de main, retard considerably (as is well known) the commencement of the third period of the siege, which is the most

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43 One may suspect his intention if he does not make his attacks on that side of the place where he ought naturally to do so, in order to take it in the easiest way. In such case the watchfulness on that side ought to be doubled.

44 In general it should be considered necessary to watch every *front* of the fortress.[1] Even when it is evident from the works of the enemy, which is his point of attack, the other sides must not be neglected; but it becomes more particularly so when there is a point which is admitted to be accessible, that it is of importance to take every precaution against sudden assault, and to do all that is possible beforehand to render it secure.

FOURTH HEAD.

See Article 'Bombardment.'

See 'Defence of Coasts.'

45 *Of Bombardments.*—Simple or irregular bombardment may be either effected by a corps of an army, which is too weak to invest a place, planting mortars hastily opposite to one of its fronts; or by bomb-ships, if the place be a sea-port. The Governor ought in such case to try and destroy the land batteries by sorties, or to burn the squadron. In either case he should multiply the number of guns on the faces which see the line of the enemy's fire.

46. Against such attempt the Governor should cause the ammunition and provisions to be placed in casemates or under bomb-proof blinds; or at least to place them in the parts of the town the least exposed to the enemy's fire.

47. He ought to establish measures for maintaining tranquillity amongst the inhabitants, and to take every precaution against fire. A well-arranged organization renders the effect of incendiary projectiles less likely to be very serious: sentinels taken from the companies of firemen (*pompiers et gardes feu*) watch the fall of shells or the direction of red hot shot; those on guard, furnished with buckets, run to the spots where fire shews itself, and put it out at its commencement. They follow the red-hot shot, throw water into the holes which they have made, seize hold of them with pincers, and carry them away in metal spoons or vessels to the nearest reservoir of water. By following this system there is less reason to fear extensive fires breaking out; and as the inhabitants themselves are interested in establishing the strictest watch, the enemy will probably not succeed in destroying the town, and he will have consumed his ammunition in vain. All examples prove that this mode of attacking places, at the same time that it does not destroy the fortifications, causes little loss to the besieged.

FIFTH HEAD.

See Article 'Blockade, Military.'

48 *Of Blockades.*—It sometimes happens that the enemy being unprovided with the means required for undertaking all the works of a siege, and supposing the place to be badly provisioned, confines himself to closely blockading it, by seizing all the avenues in order to prevent the arrival of any succour, and to force it to surrender by famine.

49 The dispositions to be made in this case are, to send away all useless mouths, to cause all the means of subsistence which the environs of the place may furnish t be brought into the town; to use the strictest economy in the distribution of pro visions and to watch the consumption of those of the inhabitants, that they m make them serve whilst the fortress holds out to the last extremity.

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1 The parts of a fortress not connected with that which is absolutely attacked should be plac d vis one each under a distinct charge, the Officer appointed to which will study the loca. take every precaution with as much consideration and energy as if certain that some effort w made against him; if such arrangement had been made, it is very possible that neither of the that actually carried Badajos in 1812 could have succeeded.—J. F. B.

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53 The investment being effected, the enemy's camp will be drawn on the plan of the place, according to which the Governor, in concert with the Commanding Officers of Artillery and Engineers, will regulate his arrangements for the defence in proportion to the enemy's progress

54 If the garrison be strong some sorties may be hazarded, but it is seldom that sorties at such a distance succeed, unless it be in consequence of the fault of the besiegers in neglecting the ordinary precautions They are besides very fatiguing for the garrison, which it is more advantageous to employ in executing the pressing works always required in a defence

55 At night he will send out small parties in opposite directions, who will creep along, taking advantage of banks or uneven ground, and proceed in silence as far in advance as possible, then, lying flat on the ground, they will listen with attention to the smallest noise, they will afterwards retire on the fortress in extended but connected order, to try to surprise Officers who may be out to reconnoitre the place These parties must agree on a signal that they may know each other

56 In the first moments the Governor may employ his good marksmen advantageously* Wall pieces should be placed on the most elevated situations and he should mix some of the marksmen with the parties sent outside the place, with orders to fire on those who may be attempting to reconnoitre the fortress

57 It is at nightfall that these marksmen, &c ought to watch with the greatest attention, that being the period for reconnoitring tracing, and pushing forward the attacks

SECOND HEAD

58 *From the Opening of the Trenches to the Crowning of the Covered way* —As soon as it is known in what direction the enemy is opening the trenches, the Governor should cause embrasures to be opened, and platforms to be laid for the guns, double rows of palisades to be planted in the covered way, useful temporary works of fortification to be made, such as fleches at the foot of the salient angles of the glacis These fleches, made capable of resisting a coup de main retard considerably (as is well known) the commencement of the third period of the siege, which is the most

* Field pieces and wall pieces should be placed in the most commanding positions and fired, without sparing against the reconnoitrers whether in bodies or single —J F B

TABLE B.—*continued.*

Laboratory materials,	Antimony	lbs.	According to circumstances, as in addition to the fireworks already enumerated.
	Saltpetre	lbs.	
	Sulphur	lbs.	
	Bk. Dgd. charcoal	lbs.	
	Isinglass	lbs.	
	Vinegar	gal.	
	Spirits of wine	gal.	
	3, 4, 5, and 6-strand cotton	lbs.	
	Red orpiment	lbs.	
	Cartridge paper	quires	
	Resin	lbs.	
	Bees'-wax	lbs.	
	Tallow	lbs.	
	Pitch	lbs.	
	Turpentine, spirits	gal.	
	Linseed oil	gal.	

The Application of the foregoing Principle to the Defence of Places.

Taking the octagon of Vauban as the example, it has been shewn, in article 'Artillery,' that the number and nature of ordnance required for that description of fortress are—

Eight 32-pounder guns for the salients of bastions	75 guns.
Forty 24-pounder guns for the flanks	
Twenty-seven 18-pounder guns for counter-batteries	
Eight 10-inch howitzers for salients of ravelins	15 howitzers.
Seven $6\frac{1}{2}$ or 32-pounder howitzers for counter-batteries	
Twenty-four 13-inch mortars for the bastions	45 mortars.
Eleven 8-inch mortars for the outworks	
Ten $6\frac{1}{2}$ mortars for the covert-way	
Field-pieces for sorties, &c.	15
Total	150

To this provision may be added a certain number of light and heavy rockets, say three of each to every piece of ordnance.

The number of artillerymen assigned to each piece for the octagon will be as before proposed to each piece.

75 heavy guns	× 7 =	525	artillerymen.
15 howitzers	× 6 =	90	"
45 mortars	× 5 =	225	"
15 field-pieces	× 8 =	120	"
Total		960	rank and file:

an apparently large number, but when divided into three reliefs it will be found inadequate, and men of the Line will be required to be attached to the Artillery, to the extent of as many more, to assist in the various duties of that Service. (See Appendix IV.)

The quantity of ammunition required for the defence of an octagon will be found to exceed 3000 barrels of 90 lbs. each.

This arrangement in the application of artillery is without reference to the duration of the defence, which is contingent on circumstances which are not to

be foreseen, therefore the maximum quantity is given for that fortress, and provided for in Tables A and B

The *Artillery operations* in the defence of fortresses usually commence on the investment, when the fire of the guns and howitzers mounted in the salients, and the mortars in the bastions, should endeavour to destroy the besiegers' *depôts parks*, and *encampments*, and at this period the heavy rockets should keep up a constant fire during the night for those objects

The second and most important period in the artillery operations is from the opening of the trenches until the besiegers artillery has full play, which period may possibly be protracted from forty-eight hours to a week under favourable circumstances by destroying the besiegers' batteries and dismounting their guns, for during this time the artillery of the place is paramount and undisturbed by the fire of musketry or guns

The Plate shewing the distribution of artillery for the defence of places will give an idea of the power of an octagon fully armed, which if used with vigour and activity, will take some time to be overpowered, and as the position of the enemy's batteries is certain, during their construction the whole force of the artillery of the place and the light rockets should be used, and the latter being laid and fired from the crest of the glacis, a constant fire may be kept up so long as the covert way is tenable.

The next period in the artillery operations for the defence is after the fire of the besiegers' batteries is in full force, for notwithstanding the immense resources of the place, that will eventually occur, and the guns be dismounted and parapets destroyed, then the ordnance in the salients and the covert way should be withdrawn and placed in the collateral fronts, the dismounted pieces removed and everything made snug, and the ammunition economized for the last effort,—the attempt to destroy the breaching batteries and impede the final advance of the besieger by a new disposition of the flank defences and the employment of the heavy mortars as pierriers

It is not necessary here to make out the minutiæ of Artillery duties during a siege which becomes a question of detail and of economical arrangements of stores ammunition, and laboratory duties, and the judicious distribution and employment of the men, which fall exclusively on that department

APPENDIX II

PROPORTION OF OFFICERS OF ENGINEERS, SAPPERS AND MINERS, AND ENGINEER STORES, NECESSARY FOR A SIEGE

In regulating this proportion some data must be fixed suitable to all places and to all circumstances classifying the fortresses under the following heads will be most applicable to our Service

Maritime fortresses	First class, or most considerable Second „ or small places
Fortresses in the interior, or on land frontiers	First class, of 10 sides and upwards Second „ of 6 to 10 sides Third „ of 4 to 5 sides

And the arrangement for calculating the number of officers and men must be separated from that for the requisite quantity of stores, the latter being regulated on the maximum quantity necessary

The proportion of officers and men may be calculated upon the same rule as that

which provides for the Artillery and men of the Line in Appendix I and IV., viz 1st, for the ordinary duties of a fortified place, and 2nd, in the event of a siege.

For the first it is proposed to assign

To the second class maritime, and third class land fortresses . .	3 Officers of Engineers, and 1 company of Sappers and Miners, including Officers
To the first class maritime, and second class land fortresses . .	5 Officers ditto, and 2 companies ditto ditto.
To the first class land fortress . .	7 Officers ditto, and 3 companies ditto ditto.

And on the probability of a siege, that force to be doubled.

Under the latter circumstance it is usual to divide the whole into three reliefs, which will be found then generally inadequate, and a certain number of artificers, usually found in regiments of the Line, will be attached to the Engineers, which is alluded to in Appendix IV. in calculating the necessary strength of the garrison

The proportion of stores, &c requisite for a siege

These essentials and indispensable resources to the Engineer department are threefold,—tools, stores, and materials; and the quantity necessary will be regulated by different rules; the first by the strength of the garrison, the second by the quantity of artillery, and the third by the nature of the fortress,—observing that the works are presumed to be in a proper state of repair.

TABLE A.—Appendix II

List of Tools necessary to sustain a Siege, calculated upon half the maximum Garrison, although only one-third or one-fourth could be employed: this allows for waste and accidents. (See Appendix IV.)—Per 100 men.

Adzes	1	Jumpers, smallest	¼
Assortment of Carpenters' tools .	½	Levels, Masons'	½
" Miners' . . .	¼	Miners' needles, of sorts . .	1
" Masons' . . .	¼	Sap forks	1
" Smiths' . . .	$\frac{1}{10}$	Saws, hand	5
Axes, felling	5	" cross-cut	2
" pick	70	" pit	1
" broad	2	Shovels, long	5
Barrows, hand	5	" common . . .	60
" wheel	10	Spades	10
Bill-hooks	30	Spare helves	30
" hand	5	Scrapers, Miners' . . .	1
Crow-bars	3	Sledge hammers . . .	5
Cart, hand	¼	Tamping bar	¼
" single horse . . .	¼	Screw or lifting jacks . .	¼
" timber (or devil) . .	½	Grindstones, large . . .	1
" forge	½	Scaling ladder, lengths of 10 feet	5
Jumpers, long	1		

TABLE B.—APPENDIX II.

List of Stores for the Defence of Fortresses, calculated upon the quantity of Artillery
(See Appendix I.)

	No.
Chevaux-de-frise, of 10-ft. lengths, calculated for 15 pieces of ordnance	15
Fascines, revetting, 18-ft.	200
„ pickets	5
„ mallets	5
Gabions	100
Nails, spike, 8-inch	100
„ „ 7-inch	50
„ „ sorts	500
Platforms, Madras } for ordnance in store for second period of attack	12
„ mortar } for ordnance in store for second period of attack	6
Sand-bags	12,000
Rope, coils { 3-inch	½
Rope, coils { 4½-inch	½
Iron 2" blocks to suit ditto	½
Ditto snatch ditto	½
Timber for magazines, cubic feet	50

TABLE C.—APPENDIX II.

List of Materials for the Defence of Fortresses, according to their nature in the proportion of each Front of Attack.

	Wet ditches, and ample bomb proofs	Dry ditches, countermines, and ample bomb proofs	Dry ditches no countermines, and ample bomb proofs†	Without bomb proof	One half bomb proof	One third bomb proof
	per front	per front	per front	per front	per front	per front
Gunpowder, barrels	5	100	10	„	„	„
Voltaic apparatus	1	4	2	„	„	„
Iron, round, lbs.	50	50	50	50	50	50
„ flat, lbs.	100	100	100	100	100	100
Pontoons, Blanshard's, large	50	„	„	„	„	„
„ „ small	50	„	„	„	„	„
Portfires	1	20	2	„	„	„
Plank* 3"—ft. supl., for repair of bridges	100	50	50	„	„	„
blindages	200	200	200	200	200	200
with countermines	„	150	„	„	„	„
without do †	„	„	4500	„	„	„
Timber—ft. cube, repair of bridges	100	50	50	50	50	50
„ blindages †	„	„	„	5000	3000	2000
with countermines	„	50	„	„	„	„
without do.†	„	„	450	450	450	450
repair of palisades,† stockades, barriers, and gates	250	250	250	250	250	250

* Thus 3" (the most generally serviceable stuff) to be cut into 1½" for mining purposes

† These quantities can only be considered as approximate and probable. The whole character of these Tables is rather that of reminders and general assistances, attempts at precision would be vain. It must be remembered that the above quantities are for one front only, when multiplied by the number of fronts in the whole polygon, they will probably insure a sufficiency for those attacked.

which provides for the Artillery and men of the Line in Appendix I and IV, viz 1st, for the ordinary duties of a fortified place, and 2nd, in the event of a siege

For the first it is proposed to assign

To the second class maritime, and third class land fortresses . .	3 Officers of Engineers, and 1 company of Sappers and Miners, including Officers
To the first class maritime, and second class land fortresses . .	5 Officers ditto, and 2 companies ditto ditto.
To the first class land fortress . .	7 Officers ditto, and 3 companies ditto ditto

And on the probability of a siege, that force to be doubled

Under the latter circumstance it is usual to divide the whole into three reliefs, which will be found then generally inadequate, and a certain number of artificers, usually found in regiments of the Line, will be attached to the Engineers, which is alluded to in Appendix IV in calculating the necessary strength of the garrison

The proportion of stores, &c requisite for a siege

These essentials and indispensable resources to the Engineer department are threefold,—tools, stores, and materials, and the quantity necessary will be regulated by different rules, the first by the strength of the garrison, the second by the quantity of artillery, and the third by the nature of the fortress—observing that the works are presumed to be in a proper state of repair

TABLE A—Appendix II

List of Tools necessary to sustain a Siege, calculated upon half the maximum Garrison, although only one third or one-fourth could be employed this allows for waste and accidents (See Appendix IV)—Per 100 men.

Adzes	1	Jumpers, smallest	$\frac{1}{3}$
Assortment of Carpenters' tools	$\frac{1}{3}$	Levels, Masons'	$\frac{1}{4}$
„ Miners'	$\frac{1}{2}$	Miners' needles, of sorts	1
„ Masons'	$\frac{1}{4}$	Sap forks	1
„ Smiths'	$\frac{1}{10}$	Saws, hand	5
Axes, felling	5	„ cross cut	2
„ pick	70	„ pit	1
„ broad	2	Shovels, long	3
Barrows, hand	5	„ common	60
„ wheel	10	Spades	10
Bill-hooks	30	Spare helves	50
„ hand	5	Scrapers, Miners'	1
Crow-bars	3	Sledge hammers	5
Cart, hand	$\frac{1}{4}$	Tamping bar	$\frac{1}{4}$
„ single horse	$\frac{1}{4}$	Screw or lifting jacks	$\frac{1}{4}$
„ timber (or devil)	$\frac{1}{3}$	Grindstones, large	1
„ forge	$\frac{1}{4}$	Scaling ladder, lengths of 10 feet	5
Jumpers, long	1		

TABLE B.—Appendix II.

List of Stores for the Defence of Fortresses calculated upon the quantity of Artillery
(See Appendix I.)

		No.
Chevaux-de-frize of 10 ft. lengths calculated for 15 pieces of ordnance		15
Fascines revetting 18 ft.		200
chokers		5
mallets		5
Gabions	"	100
Nails spike 5 inch		100
7 inch		50
sorts		500
Platforms Madras } for ordnance in store for second period of attack		12
mortar } for ordnance in store for second period of attack		6
Sand bags		12 000
Rope coils { 3 inch		¼
Rope coils { 4½ inch		¼
Iron 2* blocks to suit ditto		¼
Ditto snatch ditto		¼
Timber for magazines	cubic feet	50

TABLE C.—Appendix II.

List of Materials for the Defence of Fortresses according to their nature in the proportion of each Front of Attack

	Wet ditches and ample bomb-proofs	Dry ditches countermined and ample bomb-proofs	Dry ditches not countermined and ample bomb-proofs	Without bomb-proof	One half bomb-proof	One third bomb-proof
	per front	per front	per front	per front	per front	per front
Gunpowder barrels	5	100	10		"	
Voltaic apparatus	1	4	2			
Iron round lbs	50	50	50	50	50	50
flat lbs	100	100	100	100	100	100
Pontoons Blanshard's large	50	"				
small	50	"				"
Portfires	1	20	2			
Plank* 3"—ft. sup. for repair of bridges	100	50	50		"	"
blindages	200	200	200	200	200	200
with countermines		150	"			"
without do.†	"		4500		"	"
Timber—ft. cube repair of bridges	100	50	50	50	50	50
blindages†			"	5000	3000	2000
with countermines	"	50				"
without do.†		"	450	450	450	450
repair of palisades† stockades barriers and gates	250	250	250	250	250	250

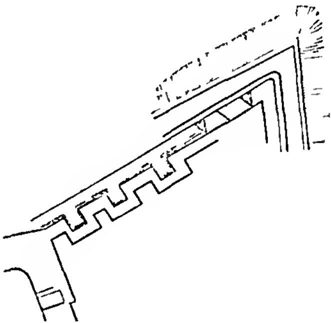
* This 3" (the most generally serviceable stuff) to be cut into 1½" for mining purposes.

† These quantities can only be considered as approximate and probable. The whole character of these Tables is rather that of reminders and general assistances: attempts at precision would be vain. It must be remembered that the above quantities are for one front only; when multiplied by the number of fronts in the whole polygon they will probably insure a sufficiency for those attacked.

effected. It is during this time that well-directed sorties, conducted and executed by the men employed under the Officers of Engineers, can protract the advance, and thus turn the defensive into offensive operations these sorties, frequent and in small numbers, should be accompanied by workmen with the means of setting fire to the gabions and fascines, sap forks for upsetting the sap, and each man with two or three nails to spike the ordnance, if the sortie should be sufficiently successful.

Want of skill in the Besieger, or other favourable circumstances to the defence, may render the counter-approach practicable, in the manner described in the figure below, and if a few fougasses (by placing boxes of powder or large shells) are employed, they will render a lodgement of the enemy difficult. The voltaic apparatus will now come into use.

Diagram of a Counter-approach—for a Collateral Front.



bags, grenades, live shells, and fire-barrels filled with pitch and fagots, rolled down Large fires have been also successfully adopted in peculiar situations, to sustain an assault on the Body of the Place.

It has been observed that the Instructions drawn up by Carnot might have the effect of giving an undue value to fortified places, and yet they should not be deemed as mere time-pieces, destined to go so many days or weeks; for that author no doubt considered that sieges were frequently undertaken with insufficient means, tempted by the neglected state of the works, or weakness of the garrison, and that an efficient siege equipment was an affair of immense magnitude, difficult to transport. However, it is when a fortress is attacked with inadequate means, that an enterprising Governor, assisted by a skilful Engineer, can take advantage of it, and convert what was deemed weak into one far above its supposed strength, as occurred at Burgos when defended by the French, and at Tarifa when defended by an Anglo-Spanish force

See 'Battery' Pl. II. figs. 6, 7.

It has been omitted to provide for mantlets for the embrasures; for after the establishment of the third parallels, it will be difficult without them for the artillery-men to work the guns. Sand-bags should be piled on the crest of the parapets to cover the marksmen, who, even after the works are destroyed, can place themselves in the ruins, and, covered by a few sand-bags, keep up a heavy fire.

In the defence of the Castle of Scilla (Sicily) by the British troops the masonry parapets were levelled; yet a few good marksmen used to creep upon their bellies, and waiting the effect of an 8-inch iron mortar (which could not be silenced), they poured in their fire on the people as they ran out of the battery, who always dispersed on the appearance of the shell in the work

APPENDIX III.

PROVISIONMENT OF FORTIFIED PLACES.

The quantity of provisions or commissariat stores necessary for a siege is one of the first essentials, and the supply for the Inhabitants should be considered, as well as provision for the garrison; for notwithstanding every means are taken to induce the families to provide for themselves, their resources are found inadequate, and they are eventually supplied from the public stores

Perhaps it would be better to take this into consideration at once, and provide a minimum ration, for each adult, of one pound of flour or meal.

In respect to the garrison, as it will probably be after the investment left wholly to the resources in the public stores, and as the duties will be very severe, it should be placed nearly upon the allowances given to Her Majesty's Navy when at sea.

Table of Provisions for Troops necessary for a Siege for 56 days, for 100 Men

		ARTICLES		Bulk in cubic feet (allowing for barrels, &c. &c.)
		Flour or meal	2200 lbs	76
		Biscuit	5600 „	358
	or	Beef, salted	5600 „	216
		Pork	5600 „	202
	or	Rice	2200 „	70
		Peas	1400 pints	51
		Cocoa	700 lbs	41
		Sugar, soft	525 „	14
	or	Spirits	1400 pints	56
		Wine	5600 „	224
		Vinegar	200 „	8
Forage.		Hay for 20 horses for 56 days	7 tons	4000
	or	Barley	7200 lbs	160
		Oats	7200 „	250
		Straw, ditto as hay	7 tons	4000

	ARTICLES		Bulk in cubic feet
Fuel for cooking only	Wood		1280
	or Coals	7 tons	350
	or Turf	(kish of 20 cub ft = 100 lbs coal)	3000
	Oil	40 gallons	4
	Candles	40 lbs	3

The bulk of these articles is given, in order that bomb or splinter proof covers may be provided for the combustible, and adequate stores for the incombustible.

APPENDIX IV.

Strength of Garrison, Quantity of Ammunition, Arms, and Stores, necessary for a Siege, exclusive of Artillery, Engineers, and Commissariat, provided for in Appendixes I II and III

The authorities given are so vague and unsatisfactory, that it is deemed preferable to form new data upon considerations framed from experience, in addition to the usual rules given upon these subjects

In respect to the *strength of the garrison*, the principle proposed for the supply of artillery seems adapted also for the contingent circumstances to which a fortress is liable *The force required, therefore, will be regulated, first, for the immediate* security of the place, and then the number to sustain a siege this arrangement avoids the necessity of shutting up a considerable body of troops without an immediate object.

It is proposed to appropriate *per bastion*, or each front of the fortress, first, for the immediate security of each place, 350 infantry rank and file,*

10 cavalry „
60 artillery „
20 sappers „

440 per bastion,

and double that number to sustain a siege for the fronts susceptible of attack, for in maritime places the former proportions will be probably adequate for the enceinte generally

The latter additional force to be thrown into the place by the General commanding the army when there is any probable risk of its having to sustain a regular attack

Of the two evils, of either having garrisons not fully adequate for his fortresses, or having a large body of troops unnecessarily pent up within them, the General commanding will find the latter very likely the greatest †

The quantity of ammunition, arms, and Quarter Master General's stores, are proposed for the maximum forces in the following proportions

Surplus arms, 1 for every four men

Wall pieces, 10 for every front of fortification

Ammunition for ditto, 500 rounds each wall piece

Musket ball ammunition made up, 500 per man

Lead, 10 lbs per man

Cartridge paper, 1¼ quire

Hand-grenades, 10 per man.

Gunpowder in barrels, 2½ lbs per man, (exclusive of wants of Artillery and Engineer Services.)

Barrack bedding, 1 set per man,

* This provides for the probable requisitions from the Artillery and Engineer Services.

† For defence of polygonal fronts 600 of all arms are considered necessary

Shoes or boots, 3 pairs per man . .	
Spare haversacks, ½ per man . .	
" great coats, " . .	These are in addition to those in possession of the troops
" canteens, " . .	
" blankets, " . .	
" camp kettles 1 for every 20 men	
Tools, felling axes, 1 for every 16 men	
" bill hooks, "	
" pickaxes "	Exclusive of Engineer stores
" shovels, "	
" hand saws, "	

APPENDIX V *

MINING OPERATIONS WHICH MAY BE UNDERTAKEN IN THE DEFENCE OF FORTRESSES WITHOUT COUNTERMINES

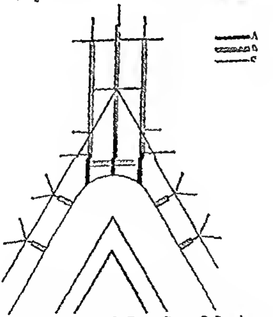
Supposing a decagon entirely without countermines it will now be explained what mining operations may be executed to strengthen the place and protract the defence.

1. For this description of fortress there should be, at least, 72 good miners, who, being subdivided into brigades of two each, so as to afford the necessary reliefs, will be reinforced by four men of the line to each brigade

2 In commencing work, the fronts most likely to be attacked should be chosen, but if all fronts are equally liable to be attacked, (which case will be supposed by way of example,) all must be provided with this means of defence

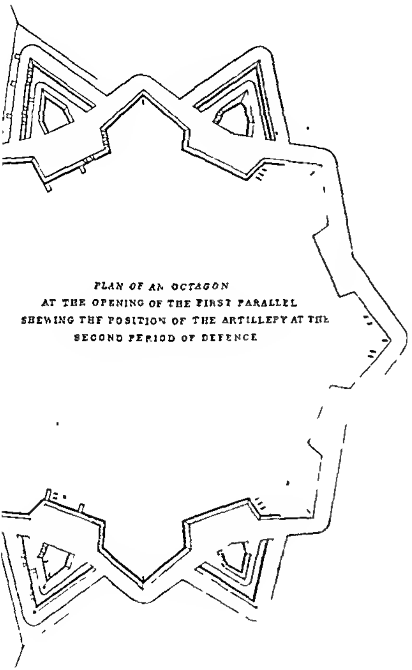
3 This question being decided upon, and presuming that the investment will last 10 days a brigade of miners should be placed on the capital of each ravelin and three principal galleries executed, as described in the diagram No 1, and extended as demi galleries to about 60 yards from the counterscarp which will bring them to where the listeners' or branch galleries should commence, at least 20 yards from the salient angle of the covert way

Diagram No 1 of Mines for Defence of Ravelin

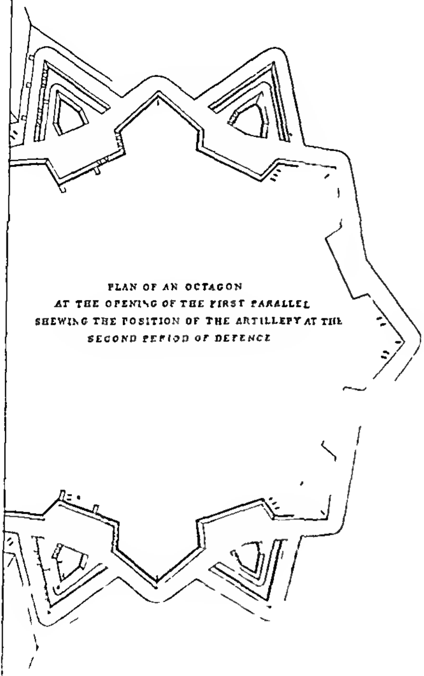


A Principal gallery B Demi gallery C Branch

* Taken from 'Manuel pratique du Mineur,' by Villeneuve



PLAN OF AN OCTAGON
AT THE OPENING OF THE FIRST PARALLEL
SHEWING THE POSITION OF THE ARTILLERY AT THE
SECOND PERIOD OF DEFENCE



PLAN OF AN OCTAGON
AT THE OPENING OF THE FIRST PARALLEL
SHEWING THE POSITION OF THE ARTILLERY AT THE
SECOND PERIOD OF DEFENCE

4 As soon as the trenches are opened and the fronts of attack known, the brigades of miners will unite from this period until the cavaliers of trenches are established on the glacis, which may be conceived to extend to 12 days more, and complete the galleries and branches as follows:

5 For the ravelins, the galleries may be prolonged as branches or listeners 30 yards, and externally 10 yards right and left; these, when completed, will afford for each of the collateral ravelins of the bastion attacked—

Principal gallery, 26 yards,
Demi „ 178 „
Branches „ 255 „

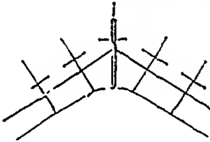
which may be easily excavated in 12 days.

6 For the bastion, there will be sufficient miners left to work at the mines to be placed under the site necessary for the breaching batteries of the enemy, the branches of which will amount to about 220 yards—one portion being placed on the capital, and two on each side, so as to torlode the counter as well as the breaching battery; and it will require 14 days to execute these works. See Diagram 2

7 It may be observed, that if the bastion attacked is very retired, or rather, if well covered by the collateral ravelins, the mining operations may be confined to the salients of those ravelins; but if the contrary is the case, then the glacis of the bastion must be principally provided with this species of defence

The probable expenditure of gunpowder will be about 7 barrels of 90 lbs. for each mine or explosion

Diagram No. 2 of Mines to be placed in the Glacis of the Bastion



G. G. L.

DEFENSIVE PRECAUTIONS.*

When a *fortress* is on the point of being invested by an enemy's army, the Governor, in order to anticipate the military reconnoissances of the hostile General, and obstruct the Engineers taking measures for opening the trenches, may draw from his own military stores, or by requisition from the merchants and shopkeepers in the town, a sufficient number of pieces of linen, calico, flannel red baize, &c, to mask the capitals of bastions and the points which would be taken for opening the first parallel, causing these, under the direction of his Engineers, to be stretched along ropes, held up by means of poles along the glacis; where those long unexpected lines of white, green, or red, set so as *not* to correspond with the angles of the fortifications, will tend greatly to throw the opponent into error, and probably

* Fragments by Colonel C Hamilton Smith K H

retard the trenches being opened for several days. These stripes of cloth should be altered more or less every night; in some places a second line of them may be raised from the points of the bastions, and carried obliquely to the curtains; and all the light troops acting as skirmishers should be out on the glacis, as far in advance as possible, to prevent all nearer access by the enemy's scientific department and Staff Officers. Hostile shot will not very readily cut the ropes, and striking the cloth will not unmask the objects behind it; but in order to leave less chance of the cloth being thrown down, each pair of poles fixed in a X shape should have the rope securely knotted, and they should not be more than 15 yards asunder.

Chains of linked sentries.

When a General invests a fortress, the commanding Engineer, though he may be materially impeded by the foregoing precautions, must not, however, suffer the Besieged to send out intelligent non-commissioned officers to creep in the night to the marks laid down by his Officers for the direction of the trenches, and change or withdraw them. He must not suffer patrols to come out, and endeavour to intercept all communication from within and without the place passing through the investing posts. Small but vigilant guards should for this purpose keep the most strict watch in the rear of the army, particularly at all bridges, fords, and narrows; the sentries keeping perfect silence, unless when challenging, and then it should be done with no more voice than is necessary for the purpose.

As the Engineers within a besieged place are fully aware of the weakest points in their defensive system, so they must be expected to be most jealous about them, and watch them with the utmost anxiety. In forming therefore the investment, it may be as well to give them uneasiness or even expectation that the Besieger has mistaken the weakest part, by affecting to push cautiously forward such light troops as are destined to approach nearest to the glacis on those points which are only of secondary consideration; but the true front to be attacked should be covered by riflemen, who, formed in chain by fours at the distance of twelve or fifteen yards from each other, advance as soon as it is sufficiently dark to prevent being distinguished by the enemy; officers and serjeants keeping even with the line, and the connection of the links being maintained by the slowness of the movement and the occasional sound of a light tap upon the pouch of the right hand man of each link passing from right to left, and then back again. On coming within the range of grape, or when the commanding Officer judges it to be time, they will receive a similar low preconcerted signal to drop on their hands and knees, crawling forward to within two hundred yards of the glacis, when three taps to halt will be given by the commanding Officer, and all are to remain (in their great coats) as near the ground as possible, excepting one in each link, who sits upright, or stands if there is cover, until relieved by his companions. The officers and non commissioned officers watch on the flanks or crawl from link to link. None are permitted to smoke, or speak louder than a whisper; none to quit the links on any account towards the front; the Officer visiting the line not to be challenged, nor to respond but by preconcerted taps on the pouch, the powder horn, or other token; none to challenge persons coming from the town until they have passed through the line of chain, and then they must be followed by a serjeant with two or more men taken from the nearest links, who in a low voice will desire them to surrender without making a noise, on pain of instant death. The person, deserter, spy, or messenger, must then be carefully watched, lest he should drop letters, &c., led directly to the rear, and given in charge at the first post and there searched, to be dealt with as may be ordered by the Officer in command of the trenches. But persons coming from the rear towards the town

must be stopped, if possible, before they reach the chain, and, if strangers, treated like the first mentioned

Should a patrol of some strength come on and pass through the chain, a sufficient number of links, making eight, ten, or twelve men, will collect, follow it, and cut off its retreat, if possible, without noise, and in no case shew more of the chain than is necessary Should light balls be thrown out, all must lie down, immoveable, till their fire is spent Just before dawn, the chain will draw further back, but not retire, because sorties are likely to be then made Therefore several non-commissioned officers should remain behind, lay an ear to the ground, listen attentively, or even crawl up to the palisades before they fall back Of course the troops in the trenches are then under arms In this manner the front of attack will be thoroughly watched, and, with sufficient light troops similarly instructed, not a single hostile individual can enter or quit the place

When the case is reversed, and the fortress is to be defended, it follows that all the instructions must be taken in a contrary manner, and the rifles in a place besieged, if trustworthy, should be kept as long as possible beyond the glacis with similar precautions

These remarks are intended for the Engineers, who may often find the troops employed on the occasion of expeditions and distant sieges unprepared by any previous instruction on this head, and therefore will then be obliged to cause some preparatory drill to be given to the troops at hand, so that they may effect the purpose intended with order and punctuality. Commanding Officers of battalions will be able to tell whether their light companies are taught the above method of enclosing enemies' fortresses, or of watching posts of importance in this manner.

At Gertruydenberg, during the late war, where the escarps were of earth, and unprotected by fraises, the writer of the above rendered them inaccessible during the winter by throwing water over them, so as to encrust the whole exterior slope with a sheet of ice

At the siege of Dantzig, in 1813–14, on the other hand, the ditches were prevented from being frozen by row boats being kept constantly moving up and down

DEFENCE OF COASTS *

In offering suggestions for the defence of open shores harbours and rivers, it is necessary to advert to the several securities required for these situations, whether from predatory attacks, or from those of a more serious character, directed against an asylum for commerce, a dockyard, &c

For the first, extensive works are seldom required, but for the latter, it may be proper to afford protection for single vessels or fleets according to circumstances, in addition to the security given by the roadstead, river, or harbour

GENERAL CONSIDERATIONS

are,—those of localities, whether the point to be fortified is near or distant from the principal towns or naval ports, if the access to those places from the landing is good, if through defiles easily defended, or an open country If the point to be defendrd is remote, the question may be confined to the local damage probable, or whether it may serve as a harbour of safety to trading vessels, particu-

* By Major General Lewis C.B R.E., with notes from Major General Harding R.E.

See Table II — 2 In deciding upon what height the emplacement of a battery should be above high water mark, 30 feet should be considered the *minimum*, *if not casemated*, and
See Appendix II — 60 feet the maximum height But in selecting the best heights reference must be
See Table II — made to the *distance* within which a *ship of war can approach a battery* the *crest* of the parapet, where there is any choice, may be regulated by the effect of the
See Appendix II — *ricochet fire on the vessel, if not within 2000 yards* *

In the event of vessels of war being able to approach within 800 yards, the cover *to the interior of the battery* must be regulated by the following depths of water

First rates will require	36	*feet* water	
Second	,,	30	,,
Third	,,	24	,,
Fourth	,,	18	,,

Steamers from 15 to 21 feet.

See Table II — 3 The distance within which shipping can approach a battery is of importance, as the level of the quarter-deck of *3-deckers is 25 feet above the line of flotation*

2 ,,	19	,,
Frigates	13	,,
Steamers	11	,,

It rarely occurs that vessels of a *small class contend with batteries, however feebly* armed

If ships of war can approach *very near* on an *equal level* and above the batteries, the latter are *seldom tenable* unless they are casemated, and if they can anchor, the destruction of the work is inevitable this *can only be avoided by a* counterguard or work *in front*, but the battery will probably be silenced

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the *traversing platforms also give a facility of traversing when directing a shot against a moveable* object such as a boat or ship —(*See Appendix I on the mode of working these platforms*)

If the batteries be well constructed the direct fire of ships has little effect, but the greatest care is requisite that the faces be not enfiladed especially in rivers ... be scarped and the supe ... int from which they may be attacked

When the ground round the beach rises high in rocky points or slopes consideration must be given ... height renders the fire of little effect without gaining any ... difficulty be elevated to ... y at the rigging as the ... and thus derange at the ... rance of harbours and ... can carry deep water ... ns must be casemated ... es arched over so that ... osition so that the bat ... osed; and under these ... crest of rising ground ... of the hill, without sub- ... cannot be obtained as ... of large ships of war ... anks, or ledges of pre- ... given to artillery on the ... ntre and débris from ... its.—G J H

It is also an axiom, that vessels of war which can come within moderate range can drive the men from the battery, that between that and 500 yards they may destroy it; and within 800 yards they may silence it, when it is built à fleur d eau, or when the upper deck guns are on the same level with the crest of the parapet

If depth of water permits this approach, the battery must be casemated to prevent the first; in the second and third difficulties the battery must be 20 feet above the level of the main deck of the ship of war, and covered with an epaulement, counter-guard, or glacis If no vessel can approach within 1200 yards, the height of the battery may be left entirely to localities, having the parapet 7 feet 6 inches above the terreplein, and the guns mounted on traversing platforms

4. The number of ordnance necessary, and their nature, for the armament of *a battery*

The first is influenced by localities, yet the purpose or object which the battery is to attain is the rule by which we are to be guided In isolated spots, one, two, or three pieces may be placed on towers when the coast is low,* which have the advantage of combining barrack and magazines and stores for ammunition, and are not open to a coup-de-main

If the ground is as high as 50 feet and more, above the level of the sea, that description of work should be avoided, as the summit of the tower is too high, even if sunk 12 feet with a ditch and counterscarp, but a small work for two or three guns enclosed by a ditch will be preferable

When there is a large or considerable open coast to defend, several batteries will be required to produce a cross fire, not exceeding 4000 yards from each other, each battery containing five, seven, or nine guns, according to the nature and importance of the coast to be defended

The nature of the ordnance should consist, when there is a choice, of one or two 68 pounders as local circumstances dictate, and the 8 inch gun of 50 cwt and 32-pounder long gun with a howitzer on the keep or interior work, but this last corresponding in calibre with the guns The supply of ammunition and stores to coast batteries is usually in the proportion of 50 rounds per piece for works of least importance, and 100 rounds for the principal batteries †

The next point which should be considered is, that booms are necessary for the protection of harbours and rivers —See 'Boom,' and 'Demolition' of Boom

No battery or batteries, however strong, can stop or prevent any ship of war or steamer entering a harbour when the navigation is free and the course is nearly direct, *if she chooses her own time* As examples—the conquest of Curaçoa is one upon a small scale, and the passage of the Dardanelles another upon the largest ‡

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* Large towers are expensive in proportion to their means of offence, but necessary in particular situations as when the space is very small or the position entirely isolated

In regard to towers it will be found that a battery with the faces directed on the point required, and closed at the rear by a loopholed barrack the whole surrounded as much as possible by a ditch and glacis, will contain more guns and men than a large tower and at less cost

Towers may, however, be used to great advantage in some situations, as on narrow points of shingle, or sand, or rocks, &c, or in commanding an entrance or strait when they are left to their own defence —G J H

† In the disposition of batteries it may be well, for the convenience of the service in the necessary supplies, to place them in masses

Guns have been sometimes placed in every situation where a gun could be useful, without sufficient regard to the service of them, or the communications with them —G J H

‡ See Table I and article 'Ordnance,' also Appendix III

APPENDIX I.

PLATFORMS—TRAVERSING, IRON.

The positions of these on works have been regulated by the Master General and *Board's order, 9th March*, 1810, with regard to iron gun-carriages,—"to be placed in such parts of fortifications as are least exposed to the enemy's fire, and in sea batteries to which heavy ships cannot approach nearer than 1000 yards." The splinters of even a wrought iron carriage, at the usual distance from each other on board ship, will destroy at least the two next beyond it. Wooden platforms as well as carriages, should always be in store to replace those of iron in case of attack; the chief merit of these last lying in economy and durability.

Figures 1, 2, 3, 4, *Plates II III.*, give the details of the regulation iron traversing platforms from 18-pounders to 32 pounders inclusive; the width between the trucks of all these carriages being the same, to suit the platforms. these last "may be adapted for front, centre, and rear pivot, and are so constructed, that by *moving or reversing the bar* that extends *from the front pivot point to* the *half distance between* it and the rear one, and by the alteration of the legs above the trucks, they may be made to traverse in any direction, and any alteration may be made that is required in the position of a traversing point between the *front* and *rear*"—"This must be done when the carriages are put together in the Royal *carriage department* at Woolwich," and this point *must be stated in the demands*.

There are yet old gun carriages in the Service, with the trucks closer in the front than rear, and this must be seen to in receiving reports, especially from detached posts, when these platforms are required

In addition to the above three *modes of traversing*, there is traversing *on the middle of the length* (not centre between trucks) of the carriage, which requires two curbs, this seems not to have been at first contemplated for iron platforms, but has been since carried into execution. This pattern must be specially applied for

When the thickness of the parapet admits of it, these platforms are fixed with the *fore* end (*a a*, Plates II III) flush with the interior face of the parapet, and having a circular indent one foot *deep in front*: the true radius of this arc will be the distance from *a* to the pivot + 1 foot.

		Pivot at front.	*Centre*	*Mid length*	*Rear*
Plate III	The several radii of the indent will be	3′ 7½″	7′ 6″	9′ 0″	12′ 0″

It must be remembered that the gun, when much depressed, runs a great risk of being dismounted, on recoiling by the lower part of the muzzle catching on the interior crest of the parapet, if not raised sufficiently above it This may be avoided when any depression is necessary, by taking care that the crest of the parapet shall be one foot below the trunnion.

"Iron gun-carriages and platforms are to be coated with anti-corrosion every two years, and not painted"—See "Anti-Corrosion"

The dwarf or Emmett's traversing platform is [illegible] ly used, and supplied by Carriage Department [illegible] apted to [illegible] parapet See Plate I

No regulation [illegible] proportion [illegible] wooden traversing platforms that a[illegible] in [illegible] depend not only on the greater or le[illegible] direct, but on the durability [illegible] with the power of the

considerations as the above (which are of especial weight in tropical climates) should be taken into account, but likewise the immediate circumstances of the times, and place, which influence the likelihood of war or peace generally, particularly if under any circumstances the point may be expected to be suddenly attacked; in such instances the wooden platform is preferable, as more generally manageable, and incomparably less liable to accidents; the mere fall of the heavier pieces of the iron platform is enough to ruin them irretrievably; not so the wooden platform, the repairs of which generally lie within the compass of colonial resources, and which may be made on the spot in most cases; but those of iron can only be obtained from England on demand.

Memoranda by an old Artillery Officer.—The blocks and tackles formerly used in working traversing platforms have been done away with, and thereby much of the efficiency of the platform itself, as to accurate and rapid firing *at a ship in motion*, has been lost. In reference to open batteries, these tackles were infinitely better, in this respect, than the handspike, and should always be in the hands of the artilleryman as part of the battery equipment, proper ring bolts* being fitted for this purpose. In small towers, where the space is confined, the handspike may be preferable to the block and tackle. The gunners should be invariably drilled to load *overhand*, and thus avoid unnecessary exposure; a lock and laniard fitted, and the gun fired at the right moment in a way that never can be done when the movement is the irregular jerking one given by handspikes

APPENDIX II †

SERVICE SUR LES CÔTES.

La flotte et l'armée de terre sont chargées de la défense mobile.

Les bâtiments à vapeur et les flotilles armés d'obusiers sont particulièrement propres à la défense des côtes

Des corps de troupes reunis dans des centres d action se tiennent prêts à se porter sur les points menacés, des batteries mobiles d'obusiers de 16e et 12e, suivant les localités, prêtent leur appui à ces corps.

Un service rapide de signaux est établi, avec les ressources locales, entre les bâtiments, les vigies, les troupes mobiles et les batteries permanentes

L'ordonnance du 3 Janvier, 1813, détermine que dans les ports militaires, l'armée de mer sera chargée spécialement, sous les ordres du commandant des forces de terre, de l'armement, du service et de la garde de batteries qui ont une vue directe sur les *ports, sur les rades intérieures adjacentes à ces ports, sur les passes et goulets conduisant aux rades intérieures*, toutes les fois que les ouvrages auxquels appartiendront ces batteries, n'intéresseront pas principalement le système de la défense, du côté de terre, de la place et de ses dépendances

Le personnel des batteries permanentes confiées au service de terre est fourni par *l'artillerie, les autres troupes, les canonniers vétérans, la garde nationale, les brigades* de douane, ou d'anciens canonniers pris dans la population des côtes, à raison de 5 hommes par pièce, dont un pointeur exercé

Les ouvrages de la défense permanente sont divisés en 3 classes, suivant leur importance

1re *Classe* —Ouvrages destinés à la défense des ports militaires, des grands ports marchands et des points principaux des îles

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* See Plates V VI, where ring bolts to correspond are shewn also on the ends of the platform as originally constructed

† Extracts from 'Aide Mémoire à l'usage des Officiers d Artillerie,' 2nd ed p 402

Cette fortification se compose de forts extérieurs capables de résister à des attaques régulières ou d'empêcher un bombardement, et d'une enceinte continue, suffisante contre une attaque de vive force.

2e *Classe.*—Ouvrages qui protègent les mouillages et les passes propres aux escadres de guerre. Ils consistent dans un système de forts ou de batteries se rattachant aux places.

3e *Classe.*—Ouvrages qui défendent les petits ports de commerce, les mouillages propres aux bâtiments marchands, les refuges de la navigation côtière. Ils se bornent à des batteries avec réduits.

Cette classification règle les approvisionnements des batteries; elle ne détermine pas d'une manière absolue leur armement, qui est subordonné à des circonstances diverses, non plus que la force de leurs réduits, également variable.

L'armement des batteries est réglé d'après la force des bâtiments qu'elles peuvent avoir à combattre, laquelle dépend de la nature de la côte, et principalement de la profondeur de l'eau.—Le tirant d'eau des bâtiments de guerre est à peu près, savoir:

Vaisseaux de	74 à 120 canons,	$7^m 5$ à 9^m
Frégates de	44 à 60 „	6 à 7
Bâtiments de	24	5
„	16	4
„	10	3

Les canons de 30* et obusiers de 22c† de la marine sont employés à combattre les bâtiments en marche, jusqu'à la distance efficace de 2400 mètres. Les canons commencent le feu à boulet plein; on continue à tirer les projectiles creux. Les mortiers de 32c‡ de la marine, dont la portée s'étend à 4000 mètres, sont réservés contre les mouillages. Il résulte de l'expérience, qu'une batterie de 4 pièces de gros calibres a l'avantage sur un vaisseau de 120 canons.

Les projectiles ricochent mieux sur l'eau que sur la terre et perdent peu de leur force, ils peuvent, après avoir ricoché, traverser à 1200 mètres le flanc d'un vaisseau de haut bord. Les projectiles creux qui pénètrent dans les bordages au-dessous de la ligne de flottaison causent de larges voies d'eau par leur explosion. (*Epreuves de Brest, 1824.*)

La hauteur à donner à la batterie au-dessus du niveau de la mer, est de 10 à 15 mètres. On doit se rapprocher autant que possible de ces limites, la 1re étant nécessaire pour mettre la batterie à l'abri des inondations dans les gros temps, la 2e permettant le ricochet jusqu'à 200 mètres et suffisant pour éviter celui des vaisseaux, qui part de 5 à 6 mètres au plus au-dessus de l'eau.

La hauteur de la batterie se prend de la crête intérieure de son parapet. Elle se compose de son élévation au dessus des plus hautes marées et de la quantité variable dont la mer se trouve au-dessous de ce niveau au moment du tir. Ces variations, qui sont inégales pour les différents points d'une même côte, et qui changent d'un jour à l'autre pour le même point, peuvent s'élever jusqu'à 12 mètres. Il importe de les bien connaître pour fixer la position de la batterie.

Tirer de plein fouet à la flottaison; si le coup est un peu bas, le ricochet l'amène sur le bâtiment. Ne tirer dans les manœuvres qu'avec des fusils de rempart. On ne fait plus usage du tir à boulets rouges. Si l'on a affaire à plusieurs bâtiments, diriger toutes les pièces de la batterie sur celui qui se trouve le plus à portée.

Connaître exactement les distances de tous les points remarquables, et l'afficher dans le magasin au matériel et dans le corps de garde, afin de pouvoir évaluer celles des bâtiments.

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* = 32 English. † = 8·661 inches English. ‡ = 12·6 inches English.

Pointer une bouche à feu de but-en-blanc sur la ligne de flottaison et la faire tourner ainsi pointée sur sa plate forme horizontale, pour rapporter la direction du rayon visuel à des objets de la côte dont les distances sont connues, avoir égard dans cette opération à la hauteur actuelle de la mer

Observer les ricochets sur l'eau

Tirer à balles sur les débarquements

Tenir en barils ou caisses, derrière l'abri de la batterie, 4 charges par bouche à feu, quelques projectiles empilés à gauche et en arrière de leurs bouches à feu, les bombes et obus l'œil en bas, les boute feu allumés en nombre suffisant.

Se garder avec soin contre les surprises, surtout la nuit, observer tout ce qui se montre en mer ou sur la côte ; être attentif à tous les signaux.

Veiller à la conservation du matériel avec tous les soins convenables, aérer les magasins dans les temps secs, faire mouvoir tous les jours les châssis d'affût

Les obusiers de campagne ou de montagne sont destinés à agir contre les débarquements, les enterrer à demi, s'il est possible, près du rivage, donnant un feu rasant et prenant les chaloupes en flanc. Ils tirent à obus contre les embarcations, à balles contre les troupes débarquées

Nombre d'hommes nécessaires au service des diverses bouches à feu.

Canons de siége	7 hommes.	Mortiers de 22ᶜ et 15ᶜ . .	3 hommes.
Obusiers de siége	5 „	Pierriers	5 „
Can sur affût de pl et côte	5 „	Bouches à feu de campagne	8 „
Mortiers de 32ᶜ et 27ᶜ . .	5 „	Obusiers de montagne . .	6 „

In addition to the above, and to the suggestions in the text as to the heights of batteries above the sea level, the following, from the same work, is given as laying down an important principle

"Nous croyons qu'il convient d'établir des principes qui ne sont pas encore assez connus, sur l'emplacement des batteries de côte Les boulets ricochent sur l'eau mieux que sur terre, et tous les ricochets, sous 2 ou 3 degres, font perdre peu de force aux gros boulets Ceux de 24, sous 4 degrés, conservent encore plus de force qu'il ne faut pour percer le flanc d'un vaisseau, tel fort qu'il soit, à 300 toises et plus ; ainsi toute batterie qui, par son peu d'élévation, sera exposée à l'égoût des ricochets d'un vaisseau, recevra tous ses coups trainans qui lui feront encore beaucoup de mal ; et toute batterie qui sera assez élevée pour tirer à bonne portée sur un vaisseau, sous l'angle de 4 à 5 degrés, *lui fera tout de mal possible, puisque les boulets trainans* de la batterie iront tous au vaisseau ; mais ceux partant du vaisseau, qui est plus bas que la batterie, ne pourront ricocher assez haut pour monter jusqu'à elle, si elle a la hauteur supposée ci dessous"

TABLE II

Shewing the principal Heights of the Guns of Shipping above the water

Rate	Class	Height of quarter deck above the sea		Height of gun-deck above the sea when it carries guns		Height of main top above the sea		Remarks
		ft	in	ft	in	ft	in	
1st	120	26	0	4	0	89	0	Main top large enough to carry a carronade
"	104	25	6	3	10	87	6	
2nd	90	19	6	5	0	86	0	
"	84	19	6	5	0	86	0	
"	80	19	9	5	0	86	3	
3rd	74	18	10	4	0	78	6	
Razee	50	14	0	7	0	77	6	
"	"	15	6	8	0	80	0	
Frigates, Corvettes, and Brigs	36	13	6	6	6	71	0	
	44	11	8	5	0	69	0	
	26	12	3	5	6	64	6	
	28	11	6	3	3	52	6	
	18	—		6	0	52	0	
	,	—		6	0	52	0	
	16	—		5	0	52	6	
	,	—		5	3	51	6	
	10	—		5	9	48	6	
Steamer		—		11	9	79	0	
"		—		11	3	72	6	
"		—		9	6	60	6	
"		—		6	2	42	8	

Column 4 —The great variation in heights, as given in this column, arises from the difference between the old and new principles of construction, in which last it is a main point to keep the guns as high out of water as possible

Column 5 —Given in consequence of the effect produced at Algiers in enfilading (at close quarters) a previously troublesome battery by hoisting a carronade into the main-top of a line-of battle ship that from its position was thus enabled to rake the work most effectually

DEFILADE

In Plan—the direction given to the faces of a work, so as to avoid enfilade, and being taken *in reverse.*

In Section—and with reference to Permanent Fortification, it implies the arrangements for preventing unnecessary exposure of the exterior and interior of works: to carry out both in conjunction is frequently an anomalous task —*See* 'Command' p 230 and vol ii., to which this part of 'Defilade' properly belongs

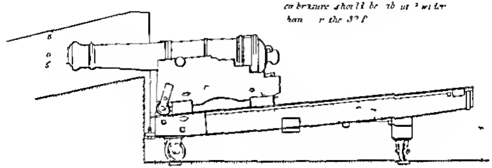
In Section—and with regard to Field Fortification where exposure of the escarp is in general of little consequence, the task is comparatively simple *as far as it is practicable,* for, with the utmost skill, it will at times become a problem admitting only of a partial solution

DWARF WOODEN TRAVERSING PLATFORM

M G & B O 1 April 18 6 pr dino that of 6 May 1844 & 18 D r 1845 Applicable from 8 inch Guns of 65cwt & 18 P and above

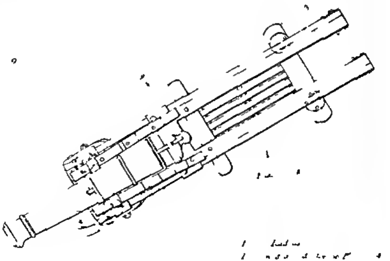
The Platform for the 56 P is 4 f t wide for this Gun the neck of the embrasure should be about 3 wider than for the 32 P

Fig 1

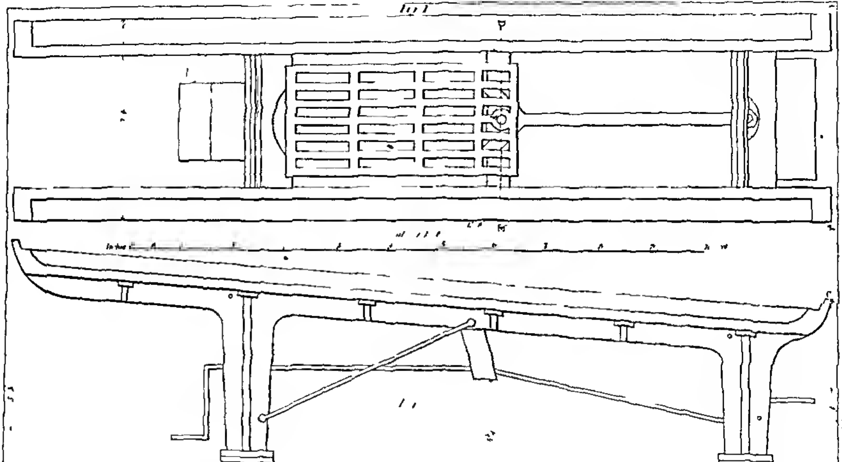


The details of S lea Pi r Gun are w d l betw are the same as the Dwarf Platform For Guns to 65 cwt neck & c a l L n t or a Gun can be work t in either For Guns above 65cwt the wart Platform is 3 inches wider but one man be which join t b l ton up the frame and blind l ke to the ad l ton l s e between h e l e

F 2



I Lad ...
I ... d ... F 4
I ... I ...



CAST IRON TRAVERSING PLATFORM FOR GUNS

AUTHORISED BY P.O. [illegible] MARCH [illegible]24

DIAGRAM OF THE CENTRAL LINES OF THE IRON RACERS,

WHEN IN FRONT _ CENTRE OR REAR

Fig 1

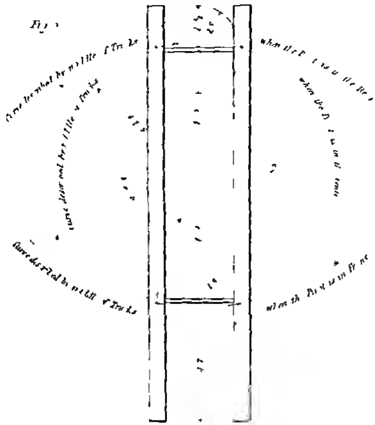


Fig 3
Front Elevation

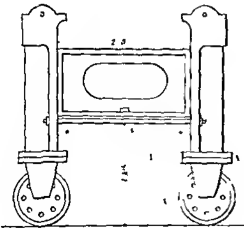
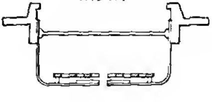
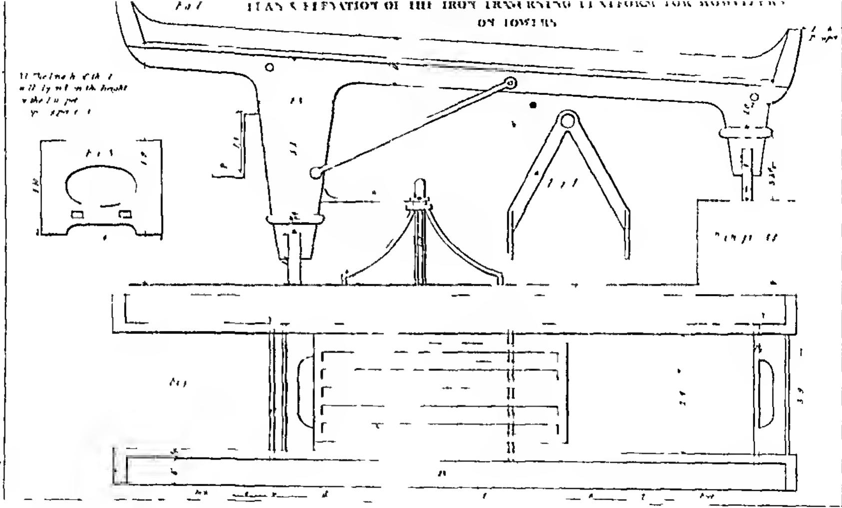


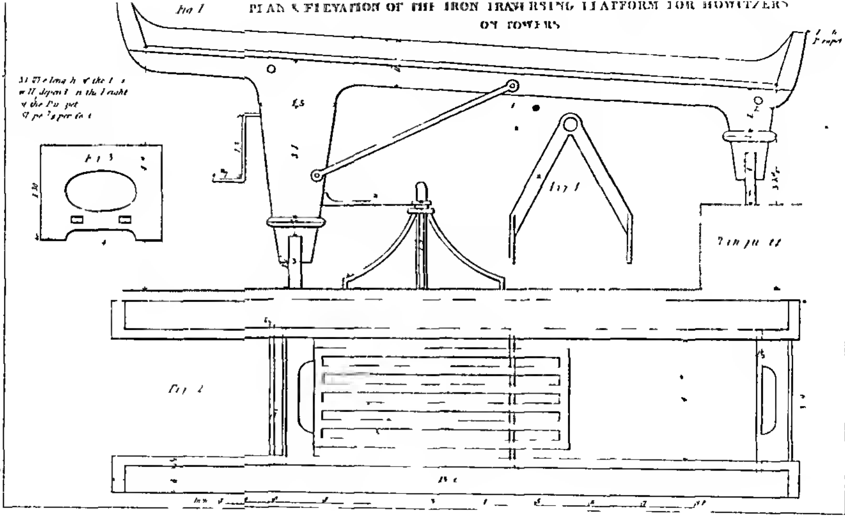
Fig 4
Section through CD
Fig 1 ...



PLAN & ELEVATION OF THE IRON TRAVERSING PLATFORM FOR [illegible]
ON TOWERS

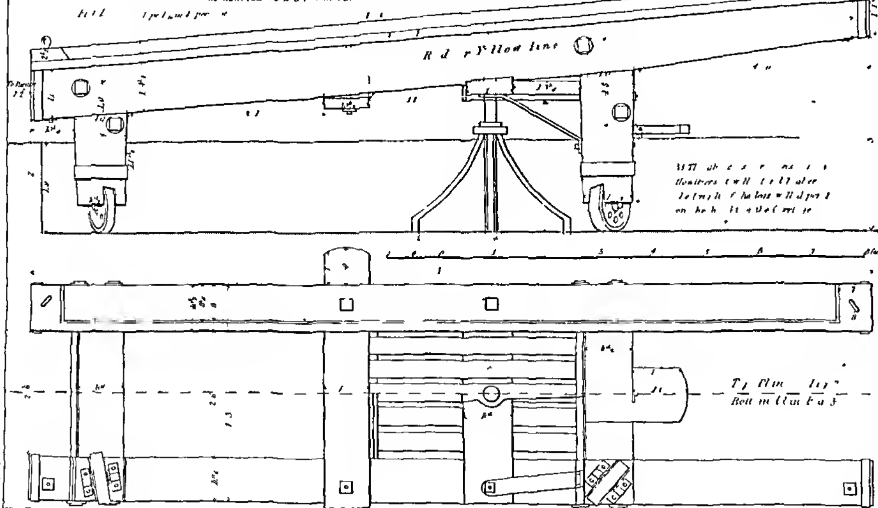


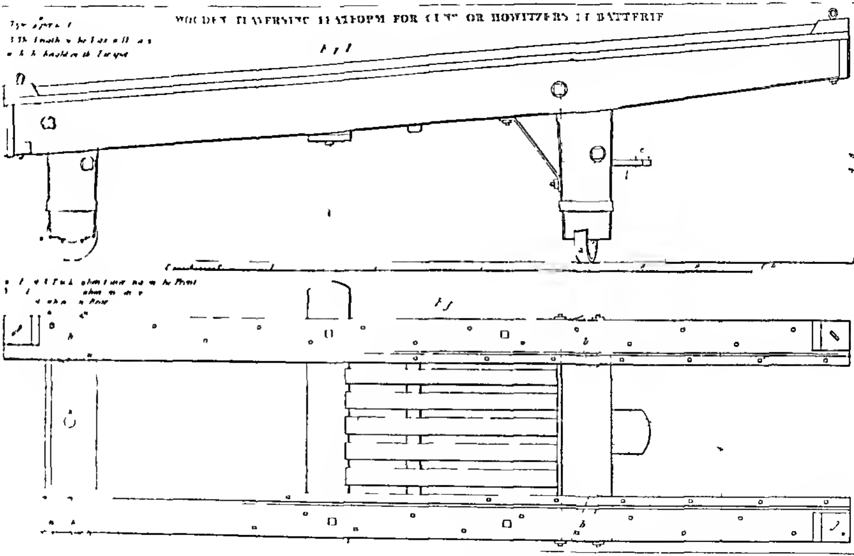
PLAN & ELEVATION OF THE IRON TRAVERSING PLATFORM FOR HOWITZERS ON TOWERS



PLATFORM FURNISHED TO THE CIRCULAR TOWERS IN ENGLAND

AS ADAPTED TO A 6 FT PARAPET IN A 20 FT DIAMETER TOWER



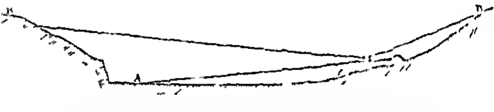

WOODEN TRAVERSING PLATFORM FOR GUNS OR HOWITZERS IN BATTERIES

To defilade a Field work, then, is merely so to arrange the heights of the different parts that the enemy may not be able to see into it; and this is more appropriately and expeditiously effected by the eye and a few poles and profiles, than by resorting to theoretical and scientific proceedings,—though these last are generally indispensable in considerations of Permanent Fortification

Defilade in plan requires no comment; as to that in section, works should be defiladed against musketry within 400 yards; and against artillery, within 1200 yards, for although this may be considered random practice, it will nevertheless keep the garrison in a state of constant disquietude

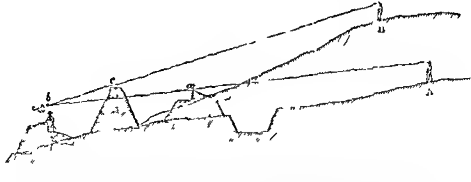
A work may require defilade either from a plain (A, fig 1) below it; or from a height or heights (B) above it, or from a height or heights (A, fig 6) adjacent

Fig 1



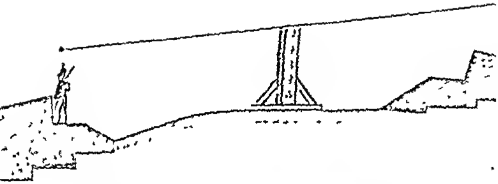
With regard to fig 1, and exposure from A or B, in either case the nearest parapet to the enemy (a, fig 2) must be, as far as possible, able to screen the space to be concealed so that the line of fire (A a) may not go less than about 3 feet over the head of the man (b) on the opposite side of the work If this cannot be done from a

Fig 2



too great command as from B, a parados (c) becomes necessary,—still affording an equal cover to b though leaving much of the space (a c) unprotected In case of defilade from musketry only (fig 3), the parados may be of two rows of plank and earth between, or of timber only the scantling may in some degree depend upon the height, but more on the nature of the wood and the distance from the enemy —See 'Barricade,' p 130, and 'Penetration.'

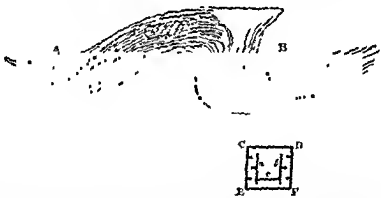
Fig. 3.



When the other lines of the work are liable to enfilade, either from the plain below or the heights above or adjacent, the best application of traverses must be made that circumstances will permit.*

Thus far relates to the simplest case—that of defilade against a single height; and with the simplicity, it often happens that the complete practicability disappears. The problem becomes more or less difficult when it has reference to more heights (A, B, fig. 4) than one, more or less surrounding a work as well as commanding it.

Fig. 4.



Thus, to prevent EF, CE, DF, from being taken in reverse from AB, the parados (a, b, c) are as indispensable as the traverses along CE DF, to give some protection from enfilade.† And in fig. 5, where an old bridge has to be secured at all risks, at the

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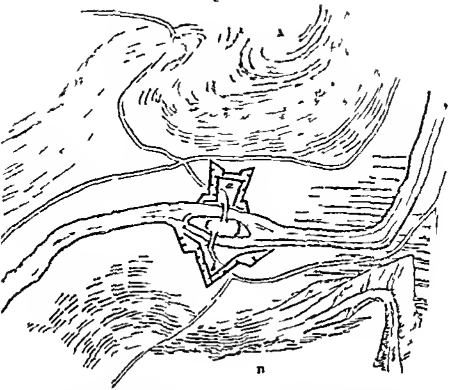
* Several of these figures are somewhat caricatured, from want of space to give them in [illegible] portion

† Placed as C D E F is with regard [illegible] but [illegible] reve[illegible] than [illegible] a sho[illegible] it ma[illegible] an ad[illegible] u rendered almost nominal by the [illegible]

Fig 5



moot of a valley of wh ch the two sides (A B) cannot be kept free from the enemy — t seems that noth ng remains to be done but to double the works by the two conformal le parados (a b) in add t on to such traverses as may be necessary It s true that neither of these pos t ons are of common occurrence and would be very objectionable were it p act cable to a o d them but such instances a e w t n the l m ts of poss b l ty and lustra e the case where complete defila le s out of the

Fig 6

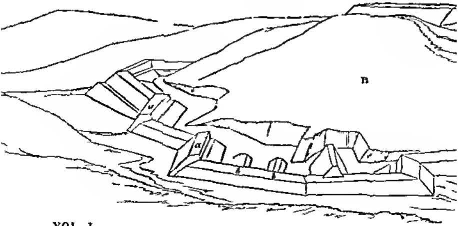
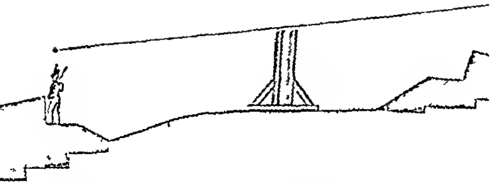


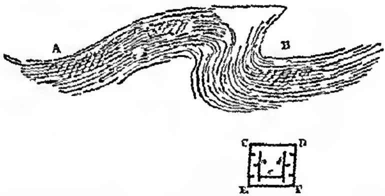
Fig 3



When the other lines of the work are liable to enfilade either from the plain below or the heights above or adjacent, the best application of traverses must be made that circumstances will permit.*

Thus far relates to the simplest case—that of defilade against a single height; and with the simplicity, it often happens that the complete practicability disappears. The problem becomes more or less difficult when it has reference to more heights (A B fig 4) than one, more or less surrounding a work as well as commanding it.

Fig 4

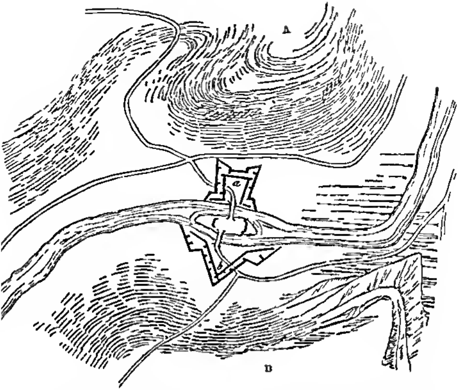


Thus to prevent EF CE DF from being taken in reverse from AB the parados (a b c) are as indispensable as the traverses along CE DF to give some protection from enfilade.† And in fig 5 where an old bridge has to be secured at all risks at the

* Several of these figures are somewhat caricatured from want of space to give them in true proportion.

† Placed as C D E F is with regard to A and B one side is taken in reverse and two are enfiladed; but it would be still worse to turn the salients towards the hills for then two sides would be seen in reverse and the rest enfiladed. Hence in such cases a face should be presented to the enemy rather than an angle. If the work be an oblong a long side should be turned towards A and B rather than a short one as the defilade becomes easier thereby. With regard however to such a case as fig 5 it matters little whether the work presents the front a to A or the salient b to A. What would be an advantage under other circumstances in having such a front as D is here rendered almost nominal by the direct fire from A and that in reverse from B.

Fig 5



mouth of a valley, of which the two sides (A, B) cannot be kept free from the enemy, —it seems that nothing remains to be done but to double the works by the two conformable parados (*a*, *b*), in addition to such traverses as may be necessary It is true that neither of these positions are of common occurrence, and would be very objectionable were it practicable to avoid them, but such instances are within the limits of possibility, and illustrate the case where complete defilade is out of the

Fig 6

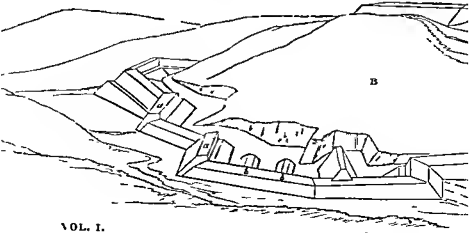


TABLE I.

Charges and Effects produced on Masonry or Brick-work *

To find the quantity of powder in lbs	Multiply by	With or without counterforts	Placed at lined intervals or how	Produces effects	Remarks
Feet. LLR³	$\frac{3}{8}$	Without,	2 lined placed at the back of a revetment	Complete but moderate	Greater charges at the same, or the same at smaller intervals, would produce violent demolition
LLR³	$\frac{1}{4}$	With	In the *middle of each* counterfort, at its junction with the escarp.	Ditto	Ditto, ditto, ditto, and if from counterfort to counterfort is unusually great in proportion to the thickness of the revetment, place one or more charges between each at the back of the revetment
LLR³	$\frac{1}{4}$	—	Centre of a line of masonry at 2-line intervals	Ditto	To produce violent demolition, or if obliged to use greater intervals, increase the charge.
LLR³	$\frac{4}{15}$	—	Under a foundation having equal earth on each side, 2 line intervals	Ditto.	
LLR³	$\frac{1}{10}$ or $\frac{1}{4}$	—	Ditto, ditto, if wood-work under foundation	Ditto.	
LLR³	$\frac{1}{16}$	—	In centre of mass of masonry base circular or polygonal.	Ditto.	Use more to avoid chance of failure.

N B — Attack a building by the same rules as revetments, or else, merely lay your charges on the ground along one side, and cover them with 2½ the thickness of the wall, with rammed earth

* Abridged from Lieut. General Sir C Pasley's Tract on Military Mines. 1837

TABLE II

Demolition of Walls of Buildings by Blasting *

L L R is of course $= \frac{1}{2}$ thickness of wall, in feet

The borer and jumper will always make a hole of rather greater diameter than its own width take great care therefore as to the true diameter obtained

Work always at an angle of 45° downwards to $1\frac{4}{10}$ L L R which will bring you to the centre of the wall Calculate how much more of the same hole $\frac{1}{3}$ of the proposed charge will fill and bore so much deeper

In the following D = diameter of the hole in inches

T = thickness of the wall in feet

When D = T (the best proportion, if circumstances admit), charge in lbs $= \dfrac{\text{L L R}^3}{3}$ at 2 lined intervals Depth of hole should be $1\frac{1}{2}$ L L R.

When D $= \frac{2}{3}$ T, charge in lbs $= \frac{2}{3}$ L L R³ at 2 lined intervals Depth of hole should be $1\frac{3}{4}$ L L R.

When D $= \frac{1}{3}$ T, charge in lbs $= \frac{1}{3}$ L L R³ at 2 lined intervals Depth of hole should be $2\frac{1}{4}$ L L R. Bore the holes, *alternately*, from contrary sides, or else at once bore 2 from opposite sides meeting as a V, or even crossing a little below, somewhat like an X In each hole put $\frac{1}{6}$ L L R³, or total charge $= \frac{1}{3}$ L L R³ at 2 lined intervals

When D $= \frac{1}{4}$ T, proceed with the same charge as when D $= \frac{1}{3}$ T, but see that the holes from the opposite sides forming an X, intersect each other well

In working with smaller borers than this instead of the V or X, bore 2 holes *close* to and parallel to each other if needful, they can be thrown into one

Where economy of powder is an object, break the lower part of the wall into piers, and place the charges in them

TABLE III

Table of Cylindrical Holes and Charges

Diameter	Powder in 1 inch of hole	Depth of hole to contain 1 lb powder
inches	ounces	inches
1	0 419	38 197
$1\frac{1}{2}$	0 942	16 976
2	1 676	9 549
$2\frac{1}{2}$	2 618	6 112
3	3 77	4·244
$3\frac{1}{2}$	5 131	3 118
4	6 702	2 387
$4\frac{1}{2}$	8 482	1 886
5	10 472	1 528
$5\frac{1}{2}$	12 671	1·263
6	15·08	1 061

* Abridged from Lieut.-General Sir Charles Pasley's Tract on Mines 18…

TABLE IV.

Table of Spaces occupied by certain Charges of Gunpowder

Space	Charge	Space	Charge	Space	Charge	Space	Charge
Side of cube in inches	Gunpowder in lbs	Side of cube in inches	Gunpowder in lbs	Side of cube in inches	Gunpowder in lbs	Side of cube in inches	Gunpowder in lbs
1	0 033	19	224 63	37	1688 13	55	5545 83
2	0 26	20	266 66	38	1829 06	56	5853 86
3	0 90	21	308 70	39	1977 30	57	6173 10
4	2 13	22	354 93	40	2133 33	58	6503 73
5	4 16	23	405 56	41	2297 30	59	6845 96
6	7 20	21	460 80	42	2469 60	60	7200 00
7	11 43	25	520 83	43	2650 23	61	7566·03
8	17 06	26	585 86	44	2839 46	62	7944·26
9	21 30	27	656 10	45	3037 50	63	8334 90
10	33 33	29	731 73	46	3244 53	64	8738 13
11	44 36	29	812 96	47	3460 76	65	9154 16
12	57 60	30	900 00	48	3686 40	66	9583 20
13	73 23	31	993 03	49	3921 63	67	10025 43
14	91 46	32	1092 26	50	4166 66	68	10481 06
15	112 50	33	1197 90	51	4421 70	69	10950 30
16	136 53	34	1310 13	52	4686·93	70	11433 33
17	163 76	35	1429 16	53	4962 50	71	11930 36
18	194 40	36	1555 20	54	5248 80	72	12441 60

"*In respect to the comparative effects of gunpowder upon masonry and common earth, it is sufficiently obvious that there are some particulars in which there can be no possible analogy between the two substances, as for instance, no modification of common earth whatever can be compared with the walls of a lofty building But, in those cases in which some analogy does exist, as, for example, in comparing the effects of gunpowder behind the back of a revetment with its effects when acting below the surface of any mass of common earth capable of retaining its form permanently without being revetted, our experiments at this place do not authorize us to say that more powder is required to produce a like effect upon masonry than upon earth; nor does it appear from our experiments that more powder is required to produce a similar effect upon very stiff compact soil than upon looser earth*"—*Lieut.-General Sir C. Pasley's Tract on Mines* 1827.

TABLE V.

The Table of Charges used by the French for demolition in masonry is herewith inserted, more particularly as it appears to have been based upon the result of experiments made for that purpose, and which were found very accurate whenever tried.

Description of masonry	Quantity of powder for	
	A toise* cube	A double metre cube †
	lbs.‡	Kilogrammes §
New, or old, masonry built or become damp [illegible]	15 to 16	7 94 to 8 47
[illegible]	18 to 19	9 53 to 10 05
[illegible]	27	14 30
[illegible] excellent		
Old masonry, same description	30	15 89
Roman masonry, or equally solid	35	18 33

* A toise is 6 ft 4·735 in English measure

† A metre is 3 ft. 3 371 in English measure

The cubic toise = 9 684 cubic yards; and the double metre cube is about 10½ cubic yards English

‡ French lb = 1 08 lb avoirdupois

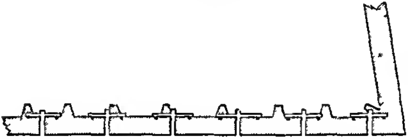
§ Kilogramme = 2 206 lbs avoirdupois

The preceding charges will be found rather greater than those given by Landmann in his 'Treatise on Mines,' calculated upon the data supplied by French authors it will therefore be safer and best to use charges calculated according to Lieut.-General Sir C Pasley's Table, but as it is always interesting to know what has actually been performed, a few examples are given.

1. At Turin the face of a bastion was blown up by gunpowder.

The height of the revetment was 32 feet, the length of the face was 318 feet, the supposed thickness of the wall at the level of the bottom of the ditch was 7 feet 6 inches, the counterforts were 3 feet thick and unequally placed, no notice was taken of them in determining the position of the charges · upon piercing the wall it was found to be only 7 feet thick, the masonry was found to be of the best quality the charges were 97 lbs, which was rather more than the quantity ought to have been, if calculated at $\frac{97}{245}$, or nearly $\frac{2}{5}$ L L R^2 the demolition was perfect; all the charges were fired simultaneously.

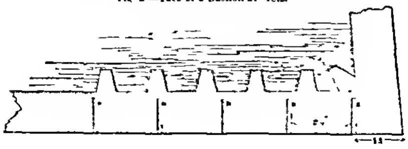
Fig 1.—Face of a Bastion at Turin.



2 Face of a bastion at Metz

The revetment was 16 feet thick at the level where the charges were placed, but as it was desired to have the line of least resistance only 12 feet towards the ditch, and to have it much greater in every other direction, the first charge was placed at 14 feet from the salient angle, the second 21 feet from the first, and the same distance was observed with respect to the others as far as the orillon A gallery was driven in from the face of the wall for each charge, and when at the proper distance, the charge was placed on the right hand side of the end of each by this mode the craters would be tangents to each other The charges were 20 lbs for each toise cube, and being fired simultaneously, the revetment and counterfort fell down in large blocks the demolition in both cases being proved equally certain, the mode to be adopted depends upon the time, or men at command.

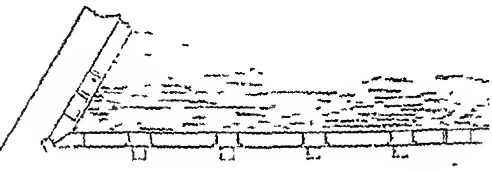
Fig 2.—Face of a Bastion at Metz.



In this last example, where the revetment was 16 feet thick, the charges were not placed behind the wall, because, by the *relative weight and comparative tenacity of th* earth and masonry, the line of least resistance would have been in the *direction of th* terreplein of the *ramparts*; besides, experience has shewn that it is only necessary t place the charge at [illegible]ths of the thickness of the wall *from the face*; that is to say, little behind the centre of gravity, *in order to throw down the entire mass. The eco nomy of time and powder by this arrangement should never be lost sight of*; the [illegible]ths to be measured *from the exterior face of the wall.*

In some cases, where a gallery runs along the back of the wall, a chamber for th powder is made in the thickness of the wall, which is filled with *one half more tha* the usual charge, and the wall secured against the *opposite side of the gallery, th* *intermediate spaces between the charges being left empty*; the two extremities of th gallery only being tamped *for a distance equal* to at least one and a *half times* the line of least resistance

Fig 3.



At Milan, in order to render the demolition *more complete by throwing down a* greater quantity of earth than *would* be the case with the simple demolition of the *revetment, the following plan was adopted* the wall at its base was 9 feet thick, counterforts 6 feet, 18 *feet from centre to centre*, the charges to destroy the wall were placed in the centre of the *counterforts*, and the *other* charges were placed in the earth behind the wall, at the distance *from* the charges in the counterforts *of 18 feet for the line of least resistance*; *the charges* in the counterforts were calculated according to the quality of the *masonry*, and the *distant charges were 300 lbs*, that is, rather more than half of the entire *charge, calculated* at 12 lbs. per double metre cube * (See Table V) The explosion *caused a great quantity of earth to be thrown* out: *to have removed the same* by shovel and barrow would have cost much more than the price of the powder

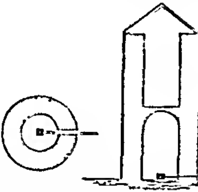
TOWERS

In the *demolition* of *towers*, some examples will be given to shew what has been accomplished with success A round tower at Ormes, 55 feet high, the walls 7 feet thick, and its interior diameter 12 feet; an arch 25 feet above the ground divided the tower into two parts; a box, containing 102 lbs of powder, was placed *in the middle of the room on the ground floor*, which was filled with earth, the fuze was conducted

* About 10½ cubic yards English

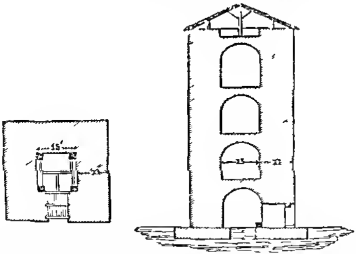
from the powder to the outside through a loophole After the explosion, the yard of the castle was filled with the ruins, without any of the neighbouring buildings being in the slightest degree injured.

Fig 4 —Round Tower at Ormea



A square tower, 75 feet high, 15 feet interior side, and of which the walls were 11 feet thick, stood isolated in Fort St. Pierre at Verona; this tower was divided into four equal parts, or floors, by four arches, the upper one supported the roof Four boxes, each containing 400 lbs of powder, were placed at the four angles of the ground floor, which was carefully filled with earth, wood, and stone; the fuze at the point of junction from the four charges was carried through the doorway, which was very firmly blocked up the tower fell in large blocks, and no fragments were thrown beyond the small circle in which the ruins were contained, and which would scarcely have been large enough, had the tower fallen down of its own accord, without any explosive power having been employed.

Fig 5 —Square Tower in Fort St Pierre, Verona



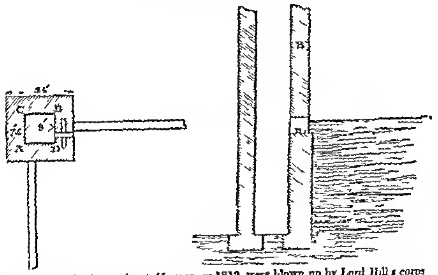
The masonry of this tower was of the best description for 15 feet from the ground, the walls were of cut stone, and for this reason it was thought necessary to calculate the charges at the rate of 35 lbs the double toise* cube, and to consider the charges

* About 77½ cubic yards English

as isolated notwithstanding the spheres of the explosion would cross each other it was supposed that the tower would not have been thrown down if the formula for conjunct charges had been adopted as none of the materials were thrown out, and as the tower fell in large blocks of 6, 9, and 12 feet of a side it must be concluded that the charges were not too great this proves that in fixing the quantity of powder, attention must be paid not only to the quality of the masonry, but still more to the height of the walls when they are very thick, and exceed 30 or 40 feet When towers are joined to the enceinte of a place, the adjoining masonry should be mined, as well as the tower if not, there is a risk of only cracking the outside, while the inner part remains uninjured

The following account of the destruction of a tower at Verona is interesting, as shewing a successful mode of procedure when there are buildings situated very near to the tower to be destroyed The tower was 75 feet high on the side next the town built on the side of a steep hill, its base was 40 or 50 feet above the roofs of the nearest houses, which were not more than 40 yards distant, the ground rising suddenly towards the fort, the face B, opposite to that facing the town, was only 40 feet high From the fear of injuring the houses, it was determined to destroy part of the tower without throwing down the entire building a gallery was made by a little door, which was in face B if there had not been a doorway, the entrance to the gallery must have been made through the wall, a chamber was made in the diagonal of the angle D, and a second at two thirds of the same face B D, which was, as well as the other faces, 24 feet of a side, outside measurement, the thickness of the walls was 7 feet 6 inches It was considered sufficient to place 50 lbs of powder in each of the two chambers, the fuzes were joined so as to cause simultaneous explosion it was expected that by this arrangement the entire face B D, and part of face A D would be completely destroyed and also a part of B C, leaving the remaining portion standing these expectations were more than realized, though no injury occurred to the houses.

Fig 6 —Second Square Tower at Verona



The towers in the works at Almarez, in 1812, were blown up by Lord Hill's corps by placing 450 lbs on the centre of the floor, and for the greater security of the miners, the powder was exploded by means of quick match, and a train carried up to the first floor, at which level the entrance gate was placed The towers were

utterly demolished by the explosion it is to be regretted that dimensions cannot be given

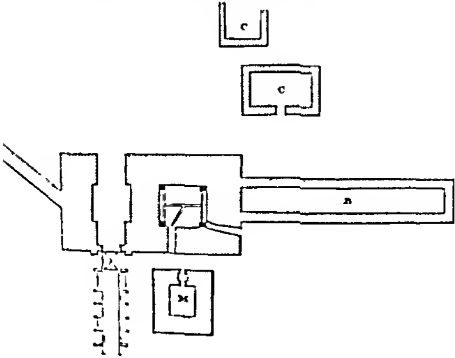
In some few instances, where no powder could be obtained, the ancient mode of mining was resorted to, and towers were thrown down by cutting away the earth under the foundations, and supporting the building on blocks of wood, the interstices between them being filled with combustible materials well ignited when the blocks were consumed the building fell, for want of support This method has been also practised for the demolition of revetments

The following account of an explosion which took place at the Fort of St Felix at Verona, to destroy simultaneously two adjoining towers, and other adjacent buildings, cannot fail to be interesting to an Engineer

The extraordinary effects of this explosion would alone be sufficient to warrant the mention of it, even if it were not necessary to speak of the additional charges that are sometimes employed to increase the violence of the commotion, and to destroy at one blow groups of objects that want of time prevents from being destroyed separately

One of these two towers was at least 85 feet in height, it was square, its interior side was 16 feet, and the walls 12 feet thick at its left, as seen from the outside, *there was another tower, which served as an entrance gate, not quite so high, but with* walls as thick as the first In front of these two towers, at about 30 feet, there was a sort of counterscarp, not revetted, in height 20 feet, and in the ditch formed by it, and exactly facing it at 6 feet from the great tower, was a square powder magazine (M), of which the interior side was 12 feet, and the walls 6 feet in thickness to the left of the tower gate and to the right of the great tower, were two walls, not backed with earth, to the last of which was joined a large building (B) that had served as a lodging for the Commandant of the Fort

Fig 7 —Tower, &c at Fort St Felix, Verona.



As the destruction of these masses bit by bit required more time than could be allowed, it was proposed to overthrow the whole by a single mine.

The great tower having one room the floor of which was on a level with the ditch and the powder magazine (M), it was resolved to place the charge there, divided in four boxes of equal size, placed at the four angles, and to make the total quantity five times the necessary charge to overthrow only the great tower. Its walls, as already stated, were 12 feet thick, and the quality of the masonry required 39 lbs. of powder for each double metre cube. (See Table V.) Thus each box, with reference to the tower alone, would have required 553 lbs.; but which, × 5, gives the intended charge for each corner, or 2765 lbs.; or the whole 4 × 2765 = 11060 lbs. Circumstances, however, caused it to be reduced to 8776 lbs., that is to say, to something less than four times the simple charge of 553 lbs. × 4 = 2212 lbs.

These four boxes having been placed at the four corners of the room, it was filled with earth, stones, and wood, the door and embrasure were strongly barricaded, and the whole was then fired.

The result of this explosion was that the two towers were *pulverized*, the powder magazine crushed, as if the charge had been placed within it, the wall of the enclosure to the left was thrown down to the extent of 130 feet; and that to the right, 52 feet in length, was entirely razed, and also the building (B): other buildings (C) that were bomb proof, and distant from the centre of the great tower from 45 to 65 feet, were destroyed or shaken in such a manner as to render them perfectly useless. This explosion (which may lead to reflection and useful calculation on overcharged mines applied to demolition) was accompanied by no accident. One single fuze flew out by the doorway of the tower which was charged, and the explosion carried some rubbish to the distance of 160 feet.

The destruction of a place consists not only in overthrowing the fortifications, but also in destroying the interior military establishments, such as powder magazines, cisterns, arsenals, &c.: we shall therefore give an account of the manner of destroying them.

Fort Conception, on the road from Almeida to Ciudad Rodrigo, was successfully destroyed by gunpowder by Captain Burgoyne,* in the year 1810, after the capture of the latter place by the French army under Marshal Massena.

Fort Conception is of a square figure with two advanced works, one of a lozenge shape, and the other that of a trapezium: the bastions were full, the curtains casemated, and a small casemate in each flank. It was proposed to sink a shaft on the line of the capital, nearly to the level of the bottom of the ditch, and a gallery carried from the bottom of the shaft near to the escarp wall of each face, with a return for two chambers. This arrangement was necessarily altered, from the difficulty of carrying it into execution; it was therefore decided to take advantage of the casemates in the flanks, which were about 12 feet cube: the ravelins were also casemated, and 5760 lbs. of powder in barrels were lodged in each, a few portions of 1440 lbs., that is, one in each face and flank.

The detached works were full of casemates, a charge of 3840 lbs. was lodged in one of the angles of the gorge, and the other advanced fort, which had two circular casemates in the shoulders of the work, was loaded with 2800 lbs. of powder. The mines, when fired, exploded with full effect: good breaches were formed in the faces of the bastions, and small ones in the flanks of the ravelins: nothing remained standing but a small part of the salient angle: the lozenge-shaped outwork was as if cut in two parts diagonally; the half in which the powder was lodged was entirely

* Now Lieut. General Sir J. F. Burgoyne, K.C.B., Inspector General of Fortifications.

blown down, and of the other work the front face and great part of the flanks were totally destroyed

MAGAZINES

When time will permit, a powder magazine is destroyed by a series of mines, placed in the centre of the thickness of its piers and of its gable these mines are then charged, according to their line of least resistance, and with regard to the quality of the masonry, they are then brought to act together, and the fall of the vertical walls necessarily involves that of the arch

When there is no time to spare, the following process is employed, which requires no preliminary work

The powder is placed in a heap, on the floor of the magazine; the doors and windows are fastened, and it is then fired by means of a hose which reaches from the powder to the outside of the building As to the quantity of powder that should be placed in the heap, knowing the interior length and breadth of a magazine, and the thickness of its piers, a revetment imagined of the same thickness, and the same quality of masonry as the piers, and of equal length with the interior line of the piers and gables,—find out the number of isolated mines that it would be necessary to place behind this 'revetment' to throw it down, and what quantity of powder would form the united charges of all these mines this quantity of powder, with the addition of half as much again, igniting in the interior of the magazine, will destroy it, without carrying the rubbish ten paces beyond it

It is not necessary, when determining the strength of the charge, to take into consideration the height of the powder magazine, because the mines being generally as low down as they can be conveniently placed, the line of least resistance refers to the thickness of the wall rather than to the height, and the ruin of the upper part of a magazine is involved in that of the lower portion

When the length of a magazine is greater than its breadth, it would be well to divide the powder that is placed on the floor in two or three equal heaps, and should the magazine in question have lateral passages, as is sometimes the case, a portion of the charge should be distributed in those passages care should also be taken that these heaps may all ignite at the same instant

BUILDINGS

Having cited numerous examples shewing the mode by which magazines may be destroyed, and which may be classed under the head of *quiet** demolition, we shall give some extracts from the Journal of the memorable Siege of Saragossa in 1808, when the French General, in consequence of the little progress he had made by an open attack against the large convents and buildings, resolved to proceed by a covered attack, that is, by mining, which henceforward was the principal operation throughout the siege, the artillery being employed as an auxiliary It is to be regretted that more details are not given, as to the thickness of the walls, and the rule by which the charges were calculated, the Engineer, however, will readily perceive of how great importance it was towards the reduction of the place that the explosions should merely produce a limited result,—that was, in general to form a practicable breach in the face of the building, by which a column or body of troops could enter without losing the benefit afforded by the remaining walls to cover their approaches or communications.

"We took possession with great difficulty of the block of houses contiguous to

* In contradistinction only to violent and hasty demolition See article 'Petard'

Santa Engracia. The Sappers worked across the first small street to the left of it, and were able to get into a room on the ground floor of a house opposite to it; however, *the enemy held most determinedly the cellars, the upper stories, and the other parts* of the building; so that not being able to drive him out of it, it was blown up. The miners placed 200 lbs. in the room which they occupied, and set fire to it; the house was thrown down, and by the consternation produced by the explosion we obtained possession of the whole block *of houses*.

"Towards Santa Engracia we blew up several houses; by the explosions a great number of Spaniards were buried in the ruins. Notwithstanding, the mines did not produce upon the minds of the enemy so great an effect as we expected; these enthusiasts, resolved *to bury themselves in the ruins of their houses, did not permit* themselves to be frightened by our firing of the mines; they did not abandon the buildings, torn and cracked by the explosions; and the briskness of their fire hindered *us from* establishing ourselves within them.

"Experience taught us that houses entirely thrown down by the mines were often an obstacle to our progress, since the ruins of them no longer afforded cover to proceed with the attack of the neighbouring houses; we could no longer cross these ruins without *infinite trouble and danger*. *The Officers of Engineers calculated the* charges of the mines in such a manner as to form a breach without throwing down the houses; the mines were particularly used *for* breaching the convents and the great *buildings, which formed a series of citadels in the interior of the city*.

"In general, when the Spaniards had been forced to abandon their houses, they set them on fire, so that the conflagration might become a barrier between them and us, whilst they could establish means of defence at a little further distance. The combustion *of the houses at Saragossa, in the construction of which there is very little* wood, is very slow and difficult, and does not communicate to the adjoining buildings: we were obliged to endeavour to extinguish these fires under a shower of hand-*grenades, or to wait several days until the houses were entirely consumed, before* being able to advance.

"We took several blocks of houses in front of St. Augustin, by opening the walls, either by blasting, by the mine, or by sap.

"When the enemy's miner appeared desirous of annoying the works, our miners hastened to load the chamber with 1500 lbs. of powder each, and fired them; that against St Francis formed a breach which was scarcely practicable. The two mines *against the hospital produced every effect that could be desired*, and we possessed ourselves of two thirds of this building, which from the first floor was an entire mass of ruins.

"*At the centre attack, our miners had entered the cellars of the hospital* to cross the Santa Engracia street by three galleries, but they were obliged to *abandon them* in consequence of the explosions of the hand grenades extinguishing the workmen's lamps.

"In the cellars of the hospital a mine was loaded with 3000 lbs. of powder; fire was communicated to it, after having drawn a great number of Spaniards within the sphere of action; the explosion was terrific, and threw down a part of the building.

"Two mines to make a breach in the University were loaded with 500 lbs. each, but did not produce the desired effect.

"It was intended to open by a mine one of the houses near the Cosso, but too much powder *having been* used, the house was *entirely* destroyed, so that no cover could be obtained to reach the adjoining house.

"A tower without any outlet prevented us from penetrating to the left of the block of houses: a passage was *opened by blasting*, and to drive the Spaniards out of

the rooms which they occupied, shells were rolled into them; the explosion of one of these shells caused all the arches to fall down to the cellar

"The miners made two chambers under the University, and loaded them with 1500 lbs of powder each; the explosions formed two large breaches

"A breach was made in Trinity church by blasting

"At the centre attack, the miners fired a chamber charged with 1600 lbs of powder placed under the great house with turrets; the half of the front was thrown down with a frightful crash, and buried fifty Spaniards under the ruins."

In 1824, after the great fire at Edinburgh Lieutenant Head, Royal Engineers, (the present Sir Francis Bond Head, Bart,) performed a very successful operation in bringing down some very high walls by the effects of gunpowder he states that he bored five holes in a line parallel with the base of the building and at a height convenient for the men to work; that the jumper was driven slanting into the wall, and penetrated one inch farther than the centre of the wall, which was three feet thick, in order that the powder should blow out both sides of it; in every instance the powder was imbedded in a stone, and not in mortar In the five holes there were 4½ lbs. of powder, but as only holes Nos 1 and 2 exploded, the others having been smothered, the effect was produced by only ⅖ths of that quantity To insure the direction in which the walls were to fall, the ruins were first braced and bound together by chains, ropes, &c. A detailed account was published at the Establishment at Chatham in 1825

CISTERNS

What has been said respecting powder magazines applies equally to all bomb proof arched buildings a cistern thus arched can be destroyed either by mines or heaps of powder, although it may be filled with water at the moment that its destruction is intended. In the latter case, a raft is placed on the water in the middle of the area of the cistern, which is capable of supporting, without being submerged, a box containing the powder required for the proposed operation, and by means of troughs leading from the box, it is fixed so as not to be deranged by the combustion of the hose that they contain, and by which the fire is carried to the powder a vast cistern was destroyed in this manner at Ehrenbreitstein

Cisterns being generally sunk in the ground for a portion of their height, in operating as above described, the arch only may be destroyed; but to render the destruction more complete, when time will permit, charges are placed under the pier most accessible the destruction of this pier brings down the arch, and consequently renders the cistern useless until rebuilt

There is also another plan which may be adopted if time will permit for its execution, which is, to sink a shaft and drive a gallery under the bottom, which, being charged with sufficient powder to embrace the entire area within the circumference of the crater after the explosion, the destruction will be complete

Without regard to the time which the Engineer can command, it may be observed that the first method, of placing the powder in a heap, is best when the cisterns are cut out of rocks, and the last two when the upright walls or piers rest against the earth

Walls may be destroyed by boring holes in them at the four corners just above the water standing in them; charging the whole with 10 or 12 lbs of powder, and firing them simultaneously if necessary, recourse may be had to a second operation of the same nature

Another mode is to suspend a box or barrel containing 200 lbs of powder, just above the water the explosion will generally prove effective

As it is very difficult to destroy a cistern cut out of rock, the next best thing to do is to fill it with materials and rubbish of any description that may be at hand.

Arsenals, hospitals, barracks,—in short, every military building —may be destroyed when there is time; and it is necessary to economize powder by the following mode:

Remove all the wood work, such as doors and windows; after which, cut away as much of the foundations as may be safe, leaving at each of the four angles of the building a column as broad as the wall is thick: if charges are lodged in these columns the result cannot well be doubtful.

When there is not time to perform the above operation, place a quantity of powder in the cellar (or on the ground floor, if there is no cellar) If it is difficult to determine the quantity of powder for the effect desired place a charge in one of the rooms on the ground floor at one end of the building; see the effect produced by the explosion, and then determine whether it will be necessary to increase or diminish the charge: In this mode of operating the ceilings should not be disturbed, and all the doors and windows on the ground floor firmly shut and secured.

At Flushing, in 1809, a fine brick building in the dockyard, four stories high, with a strong cross wall in the centre in the direction of its length, was ordered to be destroyed charges of 30 lbs were placed in each of the four angles as well as at the junction of the cross wall; the charges were not fired simultaneously; the effect was to bring down a considerable portion of each face of the building, but the charges at the junction of the cross wall were not sufficiently great to affect the superincumbent weight, as the charge blew away the loading which had been placed outside, but without injuring the wall; the loading in each case being the same

BRIDGES.

The destruction of bridges as a military operation is generally required to be undertaken under peculiar circumstances, little time allowed for performing the work, and few hands or means to execute it. It frequently happens whilst an army is before an enemy, and closely pressed by him, that a bridge is required to be destroyed, to prevent his pursuing the retreating body, or to arrest his progress, in order to gain time for the movements of the army In the retreat of the British army from Burgos, upwards of twenty bridges were destroyed, with the exception of two or three, which were only partially injured from want of time, the destruction of the others was perfect In many cases the train was not lighted until the enemy were actually on the bridge, in others, as at Cabezon, the enemy's pickets were two or three days at one end of the bridge; an Officer of Engineers during that time waiting with a lighted slow match, prepared to fire the train the instant the enemy should attempt to push on to the bridge, at the same time cautioned not to be deceived by false alarm of his advance In many instances an Officer of Engineers was unexpectedly called upon for the duty of destroying a bridge, sent off at a moment's notice 40 or 50 miles, to be followed by a muleteer carrying two barrels of powder, without a miner, or tools, other than what could be collected in the neighbourhood of the bridge to be destroyed, and with such assistance in manual labour as could be procured on the spot, or by the assistance of some of the Dragoons forming his escort The duty an Officer is thus called upon to perform is one of a most important nature, great interests are at stake, the manner in which it is executed may have great effect on the result; the fate of a campaign may depend upon it

The following details will point out the mode pursued in the destruction of bridges during the Peninsular war under the Duke of Wellington The bridges in general

On the Shannon, where several old bridges had to be removed, consequent upon the improvements making to the navigation, it was considered an excellent opportunity of testing the accuracy of the data given by General Pasley, and more particularly as these bridges being situated in the centre of towns, with dwelling houses on each bank of the river, abutting upon the ends of the bridge, large charges could not be used, without running the risk of injuring them the result appeared to prove that the quantity of powder calculated in pounds of $LLR^2 \times \frac{1}{2}$ will be found just equal to the duty of blowing down the pier and the greater part of the two adjoining arches without dispersing the materials. This, in some cases, would be objectionable, as the mass of stone, &c thus falling into the water way of the arch might, if the river was not very deep, greatly facilitate the passage of troops, and certainly aid very much in the operation of repairing the bridge This would be an additional reason for using a much greater charge than the rule prescribes in order that the materials may be dispersed, and if the explosion does not take place until an enemy is close upon the bridge, he will be liable to lose a great number of men by the falling stones There is also another reason which may be urged for using large charges the fracas and noise of the explosion, and falling materials will have a great effect upon soldiers who, if accustomed to silent demolition, would not hesitate to rush on, and attempt to disturb the train, which might have been done on the bridges at Athlone and Carrick, where the demolition was silent but perfect, scarcely any report from the explosion, and unattended by danger to any person who might have been standing upon the bridge, just clear of the line of fracture of the arch.

For details of the demolition of the bridges at Banagher and Rooskey, see Appendix D.

BARRIER GATES

The Petard (the ancient machine or instrument for blowing down gates, or barriers, at the entrance to a fortress, causeway, or building) has for many years been in disuse in the British Service, having been found too unwieldy an instrument for attacks by surprise, or even at any time, under any circumstances a bag of powder has been substituted, and it is believed on every occasion, where applied, with success

Many experimental trials have been made at the Royal Engineer Field Establishment at Chatham ,and also at Quebec. In vol vi. of the Professional Papers of the Corps of Royal Engineers an account is given of two experiments made at Quebec in the year 1840

The first experiment was against the outside of a pair of sallyport gates: the gates were 4 inches thick, 2 inch oak doubled, fastened inside by an iron strap 18 inches, $2\frac{1}{2}$ inches by $\frac{1}{2}$ inch and further were secured by two bars of $1\frac{1}{4}$ inch round iron, fixed at one end by staples to posts in the rear, the other end was attached to the gates near the centre The quantity of powder used was 50 lbs., sewn up in a leathern bag; it was suspended to one of the gates on the outside near the centre, the effect of the explosion was to destroy that half of the gate to which the bag was attached, the other was not so much injured the gates were opened sufficient to allow four or five men to pass in abreast.

The second experiment was attended with much the same success as the first; but it appears evident, as very justly remarked by the Officer* who conducted the experiment, that a greater charge ought to have been used by 10 or 15 lbs., it being evident that had the gates been equal in strength to the entrance gates of fortresses,

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* Capt. Simmons R.E

it is most probable that an assaulting column would have found it difficult to pass through the opening

It appears from these experiments that the piers of the gates, although of green masonry, were uninjured by the explosion, and that the effect of the powder was chiefly at the point of suspension hence, from the details given, it may be presumed that if the gates had been more strongly fastened, or if there had been iron stays at the top and bottom rails, a mere hole would have been blown through the gate, unless the charge had been doubled, in fact, the gates were only partially blown open, though the injury caused by the explosion was sufficiently great to enable a few men to pass through, which is the principal object to be attained this is more easily, quickly, and better effected by a bag of powder than by any other means at present in use The East India Company's Engineers have had opportunities of thus applying bags of powder. At Ghuznee, in 1839, a charge of 300 lbs was used with success, divided and placed in twelve sand bags, with a hose 72 feet long it is supposed (although the account does not state it) that the bags were merely laid down on the ground at the foot of the gate, and there exploded *

During the war in China, at the storming of Chin Keang foo, 160 lbs of powder, in bags, placed on the ground, blew a large two leaved gate off its hinges, and flung it, almost uninjured, several feet back into the archway, though this last had been in a great measure filled up with bags of grain, &c, to obstruct the entrance

LOCKS AND GATES

In the principal maritime fortresses there are generally large basins in which men-of war remain afloat, the water in them being retained by large gates, with a chamber for the ingress or egress of the vessels A description of the operation † of destroying the chamber between the lock gates at Flushing is herewith given the result was everything that could be desired, the work was completely destroyed, and the explosion effected its object quietly, and without the slightest injury to the adjacent houses

"The length of each pier was 128 feet, the thickness varied from about 27 to nearly 33 feet, and the height, above the floor of the entrance chamber, was 26 feet, the whole of solid brick work, except a small arched channel or culvert, which ran longitudinally through the upper part of each pier

"The object being to render these piers unserviceable, with the least possible injury to the town of Flushing, it was proposed so to place the charges that the foot of each wall should be blown into the entrance or lock chamber, and that the upper part of the wall, instead of being thrown upwards by the immediate effect after explosion, should fall as its consequence, or be so rent as to be incapable of partial repair.

"The position fixed upon for the charges was two feet above the floor of the lock chamber, and with a line of least resistance towards the face of each pier of 9 feet

"The explosion was to take place at low tide, when there would be 7 feet depth of water in the entrance chamber

"Four mines were determined for each pier, to be equally distributed and fired together, the charge of each to be three barrels of gunpowder, or about 270 lbs

"A shaft, 7 feet square, was sunk for each mine in the ground immediately at the

* When the quantity of powder admits of its being hung to the centre of the gates as was the case in the Quebec experiments, the party should be provided with a large gimlet or two as the readiest and quickest way of suspending the powder bags —J F

† Abridged from Major General Fanshawe's Report —Professional Papers vol ii

back of the piers, and upon reaching the required depth in each, a gallery 4 feet 6 inches high, and 2 feet 6 inches wide, was driven through the brick-work to the position for the charge

"The general average of work accomplished by the miners was about 1¾ inch length of gallery per hour.

"Having reached the length intended for each gallery, a return was made for the chamber, of which the following is a section:

"The boxes to contain the charges were in the clear 19½ × 19½ × 22½ inches, made of 1¼ inch deal, the bottom covered with tarpaulin, and the cover made to fit exactly with ledges

"The auget was fixed to, or rather housed into, the centre of the side of the box towards the gallery

"A slight bridge was thrown across the entrance chamber, from pier to pier, the mines were connected together by the hose, and fired by a portfire equidistant from the centre of each charge, allowing 4 inches for every right angled turn

"The mines were exploded at low water, and the flood gates were opened the effect of each charge (excepting two on the eastern side, where the powder had become damp, and the explosion consequently only rent the pier,) was to blow out the bottom of the wall, and to destroy the adjoining part of the floor, which was of oak the bottom of the piers being thus removed, the upper part almost immediately fell.

"So completely was the desire that the town should not suffer fulfilled, that not even a square of glass was broken in the lock house, situated about 30 feet in rear of the western pier, whilst the effectual destruction of the piers themselves was accomplished"

References upon any of the above subjects may be made to the Professional Papers of the Royal Engineers, Sir John Burgoyne's Paper on the Destruction of Bridges, pp 196 197, Sir John Jones's 'Sieges,' Landmann, Pasley, Gompertz and Lebrun, Mouzé, Rogniat, &c, &c.

BOOMS

In giving the following decisive experiment as to the facility of destroying booms *when unopposed*, it is right to refer to the third paragraph of the article 'Boom,' in which it is expressly stated that they must never be left unobserved or unprotected

"Another interesting experiment took place yesterday off the *Excellent*, Captain Chads, on the most speedy and efficacious mode of destroying a boom which might impede the progress of boat squadrons in narrow rivers, as in the case of the recent attack on the pirates of Borneo by the squadron under Rear Admiral Sir Thomas Cochrane.

"The first experiment took place on Friday last, but was on a smaller scale than the present, consequently not so convincing or successful in its results

"On the present occasion two line-of battle ships' lower masts* were taken from the old mast pond, and moored at a short distance from the *Excellent* Six turns of small chain lashing secured the two spars in the centre: the ends of the spars were secured by two half hitches of chain, and two parts of the chain cable ran along the spars and were secured in the same manner round the opposite extreme. The spars being thus secured, as if at the entrance of a river or creek, to prevent intrusion the operations now commenced to dislodge them —A breaker, containing 56 lbs of gun-

* Diameter 27 inches length 90 feet.

It is most probable that an assaulting column would have found it difficult to pass through the opening

It appears from these experiments that the piers of the gates, although of green masonry, were uninjured by the explosion, and that the effect of the powder was chiefly at the point of suspension: hence, from the details given, it may be presumed that if the gates had been more strongly fastened or if there had been iron stays at the top and bottom rails, a mere hole would have been blown through the gate, unless the charge had been doubled. In fact, the gates were only partially blown open, though the injury caused by the explosion was sufficiently great to enable a few men to pass through, which is the principal object to be attained this is more easily, quickly, and better effected by a bag of powder than by any other means at present in use The East India Company's Engineers have had opportunities of thus applying bags of powder At Ghuznee, in 1839, a charge of 300 lbs. was used with success, divided and placed in twelve sand bags, with a hose 72 feet long it is supposed (although the account does not state it) that the bags were merely laid down on the ground at the foot of the gate, and there exploded *

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"A slight bridge was thrown across the entrance chamber, from pier to pier, the mines were connected together by the hose, and fired by a portfire equidistant from the centre of each charge, allowing 4 inches for every right angled turn

"The mines were exploded at low water, and the flood gates were opened the effect of each charge (excepting two on the eastern side, where the powder had become damp, and the explosion consequently only rent the pier,) was to blow out the bottom of the wall, and to destroy the adjoining part of the floor, which was of oak the bottom of the piers being thus removed, the upper part almost immediately fell.

"So completely was the desire that the town should not suffer fulfilled, that not even a square of glass was broken in the lock house, situated about 30 feet in rear of the western pier, whilst the effectual destruction of the piers themselves was accomplished"

References upon any of the above subjects may be made to the Professional Papers of the Royal Engineers, Sir John Burgoyne's Paper on the Destruction of Bridges, pp 196 197, Sir John Jones's 'Sieges,' Landmann, Pasley, Gompertz and Lebrun, Mouzé, Rogniat, &c, &c

BOOMS

In giving the following decisive experiment as to the facility of destroying booms *when unopposed* it is right to refer to the third paragraph of the article 'Boom,' in which it is expressly stated that they must never be left unobserved or unprotected

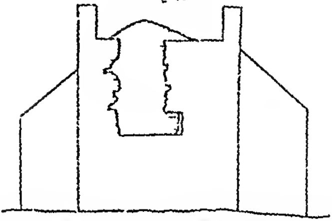
"Another interesting experiment took place yesterday off the *Excellent*, Captain Chads, on the most speedy and efficacious mode of destroying a boom which might impede the progress of boat squadrons in narrow rivers, as in the case of the recent attack on the pirates of Borneo by the squadron under Rear Admiral Sir Thomas Cochrane.

"The first experiment took place on Friday last but was on a smaller scale than the present, consequently not so convincing or successful in its results

"On the present occasion two line-of battle ships' lower masts* were taken from the old mast pond, and moored at a short distance from the *Excellent* Six turns of small chain lashing secured the two spars in the centre the ends of the spars were secured by two half hitches of chain, and two parts of the chain cable ran along the spars and were secured in the same manner round the opposite extreme. The spars being thus secured, as if at the entrance of a river or creek, to prevent intrusion, the operations now commenced to dislodge them —A breaker, containing 56 lbs. of gun-

* Diameter 3" inches length 90 feet.

Fig 14



mid-width of the bridge, so that the charge (lodged in one face of the shaft, and at the bottom) might be exactly in the centre of the pier and roadway; the tamping consisted of the excavated materials replaced Bickford's fuze was used to ignite the charge,* and one man was told off to fire each shaft the whole were lit at once by signal. "The explosions were nearly simultaneous, the entire bridge appeared to be raised a few feet, and then fell in a confused mass of stones, with the exception of a small portion of two piers, which remained standing no stones were thrown to any distance, and the demolition might be considered perfect The patent fuze answered admirably, as it has in all cases where it has been employed on the Shannon, and at other places where I have had opportunities of using it."

Roosky Bridge

Consisting of good external rubble facing generally speaking filled (in both piers and spandrils) with loose earth and stones,—except where two parallel walls, about 18 inches thick, and 3 or 4 feet on each side of the centre, ran like partitions along the whole length of the bridge, crossing the spandrils, and passing down into the piers,—one large arch in the centre, and four smaller ones on each side. The six piers of the seven central arches were from 6 to 7 feet thick; the two piers nearest the abutments were 20 feet thick

As it was necessary to avoid ruining the temporary wooden bridge running close alongside of it, very moderate charges were advisable; hence, experimentally, $\frac{LLR^2}{32}$ was tried at first in one of the 20 feet piers, and one of the small piers, but unsuccessfully $\frac{LLR^2}{20}$ was then tried for both the large piers, and a much higher proportion $\frac{=LLR^2}{2\ 75}$ for the small ones The result was only partially successful in the latter, but by re loading those that had suffered least with $\frac{LLR^2}{1\ 318}$, the remainder were all brought down, excepting half an arch, which fell next day This example is valuable, as giving a limit beyond which success cannot be expected The bridge was an indifferent structure, and the charges the lowest possible

The voltaic apparatus was used in this last instance, with, as usual, complete success as far as instantaneous ignition was concerned.

The powder used in the preceding cases was from private mills, strength $= \frac{19\ 5}{21}$ of Government L G

* The Civil Engineer apprehensive of failure put two fuzes, but the precaution was unnecessary

APPENDIX F.—Including Table VI.

General notices for Demolition, in reference to—

A. The position of the charge—
B. The mode of reaching the point where it is to be—
C. The amount and size of the charge itself—

With regard to—

1. Revetments not exceeding Vauban's ordinary profile.
2. Revetments exceeding Vauban's ordinary profile, or in very massive pier walls.
3. Towers.
4. Cisterns.
5. Military buildings.
6. Bridges.
7. Barrier gates and town gates.
8. Booms.

A

A. With time. A 1. See fig. 1.
A 2. See fig. 2.
A 3. See fig. 6.
A 4, 5. In the heart of the walls, and particularly at the angles: or else, cut the lower part of the wall into piers, and deposit the charges in them.
A 6. In the piers, generally in two charges along the axis of the piers.
A 7. Powder bags, hung up at the centre.
A 8. Powder-cases, merely pushed under.

A'. Against time. For all—adopt the most expeditious plan.

A' 1, A' 2 } In these, regulate the decision by hardness of escarp
—hardness of backing
—total work in gallery, or
—total work in shafts
—quantity and quality of labour available
—quantity and quality of stores.

A' 3, 4, 5, 7. Powder merely in bags, boxes, or barrels, in a heap within, with such tamping as the case admits of. Figs. 4, 5, 7.
A' 6. The powder sunk as deep on the crown of the arch as time permits, and loaded with what materials may be at hand.
A' 8. As before.

B

B. With time. B 1, 2, 6. By shafts. Figs. 11, 12, 13, or
By galleries from the front, e. g. Figs. 1, 2, 10, or
By galleries along the rear. Figs. 3, 8.
B 3, 4, 5. The short gallery. Fig. 6.

Mem. B 1, 2, 6, generally become a question of economy in labour and stores; but should there be any deficiency in skill, or in such stores as mining frames, &c., the simplest plan is the shaft, if the material is firm enough to stand unsupported.

B'. Against time. B' 1, 2, 6. The shaft. Figs. 11, 12, 13.
B' 3, 4, 5. The short gallery. Fig. 6.

C. (See Table VI.)

C. With time. C 1, 2. (On two lined intervals.) $\frac{1}{2}$ LLR³.
C 3, 4, 5, 6. $\frac{1}{15}$ to $\frac{1}{2}$ LLR³.

C'. Against time. C' 1, 2. (On two lined intervals.) $\frac{3}{4}$ LLR³ and upwards.
C' 3, 4, 5.—$\frac{3}{4}$ LLR³ and upwards.
C' 6. 300 lbs.—1000 lbs.
C' 7. 75 lbs.—300 lbs.
C' 8. 56 lbs.—112 lbs.

TABLE VI

Abstract of preceding instances of Demolition

Place	Nature of work	Material mined in	Location of Mines	Average distance of charges apart in L L R	Charge in lbs	L L R feet	Ratio of charge in lbs to L L R3 in feet	Remarks
Turin A	Bastion escarp	Best masonry	Rear of escarp, and in counterforts	1 8	97	7 0	282	Demolition complete Foreign powder
Flushing B	Piers of lock gates	Brick	*In* the pier	2 55	270	9 0	37	Do British (Government) powder
Quebec C	Bastion escarp	Good rubble masonry	Rear of escarp and in counterforts	1 3	{ 70 50	9 0 8 0	096 097 }	Do Do
Corfu D E	Escarp Casemate	Rock and masonry Masonry	Rear of escarp At end of the casemate each side of pier	3 ×	205 750*	5 0 14 0	1 64 273 }	Do, Admitted to have been excessive Foreign powder
Sheerness F	Bastion Escarp Ravelin escarp	} Good brick work {	Rear of counterforts Rear of escarp and centre of counterforts	2 2	84 25	7 5 5 0	2 2 }	Do Calculated on Lieut Gen Sir Chas Pasley s Rules Government powder
Banagher G	Bridge	Very inferior rubble	Piers	×	88	7 87	102	Do Do do Merchant powder
Shannon† H	Bridges generally	Average masonry	Piers	+	"	L L R3	33	Do Merchant powder
Verona I	Tower	Brick or masonry	*Heart of the wall*	×	80	3 75	95	Do Foreign powder

Deductions from the above as to Escarps—i e from A to F

Taking into account the use of *foreign* powder, and other circumstances, B, C, and F are the only cases that can be fairly compared Of these, F, as established by Lieut General Sir Charles Pasley, affords the best basis, and taking the distances of the charges apart into account, it is very reasonably supported by B and C, and somewhat more approximately by A and E B seems to be the most advisable in cases of doubt or expedition

Considering what immense powers and unwieldy masses are generally opposed to each other in demolitions, and the rude results that, after all, are to be obtained there is no ground for expecting a *very* close coincidence in these cases

* *The two charges of 375 lbs were very close together*

† Excepting Roorkey, which was too peculiar for comparison

DEMOLITION OF ARTILLERY.

COMPLETE DEMOLITION.

Iron Guns *—"The mode that I have generally adopted is to half fill the gun with powder, and jam in one or two shot with stones, bits of iron, &c ; over this a complete tamping with stones and a little earth, till the bore is filled. I have seen this done with more than a hundred guns, and never knew it to fail † To break off the trunnions is by no means an infallible mode of destroying ordnance: the French, in 1807, near Tarentum, had the guns of a battery thus imperfectly demolished in action,—in half an hour after, the work was recovered: they were probably fired on the ground. The place of the trunnion has also been temporarily supplied, in the British Navy, by passing a chain round the carriage (vertically) and slinging the gun in the bight, the breech of course resting on the quoins. The difficulty in laying a gun accurately when thus deprived of trunnions is very effectually met by laying a long triangular batten along the line of sight for the time being,—the vertex of the batten on the base ring, and the other end or base on the muzzle-mouldings,—this base being equal to the difference of the radii of the gun at those two points, so as to render the gun for the moment a cylindrical piece, and do away with dispart. The upper edge of this batten should have a groove along it, and be painted white. When time admits of only crippling guns partially by removing the trunnion, this is best done by laying its end on a block of wood, the blow being given by a sledge-hammer, or (if that be not at hand) by heavy shot; but the hammer is preferable as being more under control"

A shot may be fired at the gun behind the trunnions, which, if it should not break it, would render it unsafe. When old ordnance is sold, it is usual to break off one or both of the trunnions, to prevent their becoming an article of trade, except as old metal.‡

Brass Guns.—A shot is fired into them from some other piece, behind the trunnions which will prevent the possibility of their being used again ‡

At Madrid, on finally evacuating it, the French destroyed their brass battering guns by keeping them over large fires till they 'drooped,' though, when well heated, a few smart blows from a sledge hammer will render such guns useless.

TEMPORARY DISABLEMENT

The spring spike is used in rendering one's own guns for a very short time useless to the enemy,—as when guns are confidently expected to be quickly recaptured on the field. In this case, the gun would also, if possible, be dismounted, the rammer, &c , &c , would be taken away at all events

The common spike would be used when the guns, on either side, are to be disabled as much as possible, though time does not admit of a more effective operation. This spike consists of a long tapering cone,—the larger end of steel, and the rest of soft iron, so as to bend back when driven well down on the lower surface of the bore

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* For the first paragraph we are indebted to the verbal communications of Captain Sir Thomas Herbert R. N

† The doubt existed in consequence of a failure during the late war in destroying some French 36 prs in a battery on the coast of Calabria. It has been suggested by an Artillery Officer that partly burying the muzzle of an iron gun would be an assistance, if any doubt existed as to the efficacy of the processes now detailed

‡ Paragraphs from Notices by Colonel Dundas C B R.A

one toggled to the selvagee on the old mast, and the runners, guys, &c., being cast off, the old mast may be hoisted out by the new one"

SHEERS.

Used for lifting and manœuvring a class of subjects too unwieldy for the derrick, and requiring greater control in management than it can afford. Amongst the severest practices are the lifting masts into ships in different ways any probable Engineer operations of this description would be trifles compared to them.

Particular attention should be paid to the mode of moving sheers from place to place without taking them down, by means of the guys and heel ropes.

GETTING IN LOWER MASTS AND BOWSPRIT

1. *Setting up the Sheers*

fig 3 "Sheers* for getting in the lower masts and bowsprit † are made of two large spars: a strong lashing secures them by their heads (*a*) Over the head of the sheers, at the lashing, a large three or fourfold block (*b*), according to the size of the largest mast to be got in, is secured, connecting itself by a fall to another block (*c*) At the head of the sheers are four ropes, called *guys*, two leading forwards and two aft (*d*) Also at the upper end of one spar, a girt line block (*e*) is made fast, and its line reeved through it this is to hoist up a man in case of emergency At each heel of the sheers there is a tail tackle (*f*) leading aft, and two others (*g*) are overhauled forwards

"Previously to the sheers being raised, two planks (1, 2), long enough to lie over three beams, (which are shored below,) are placed upon deck on each side, for their heels to rest on

"The lashing of the sheers is passed like a throat seizing not too taut, and then the heels of the sheers are drawn asunder they are laid over the taffarel (*h* fig 4), and (if the ship do not carry a poop) to make them rise easier, a spar (*i*) is laid athwart over the fife rails The lower purchase block is then taken forwards, the fall (*k*) being overhauled, to the breast hook, or the ring bolt in the stem, for the main-stay The fall being taken through a leading block, is brought to the capstan, and hove upon The cross spar (*i*) cants the sheers and their heels are prevented from flying forwards by the tail tackles

"When the sheers are up, they are moved forwards or aft by the guys and heel ropes

"The guys are hauled taut and the block cast off from the breast hook."

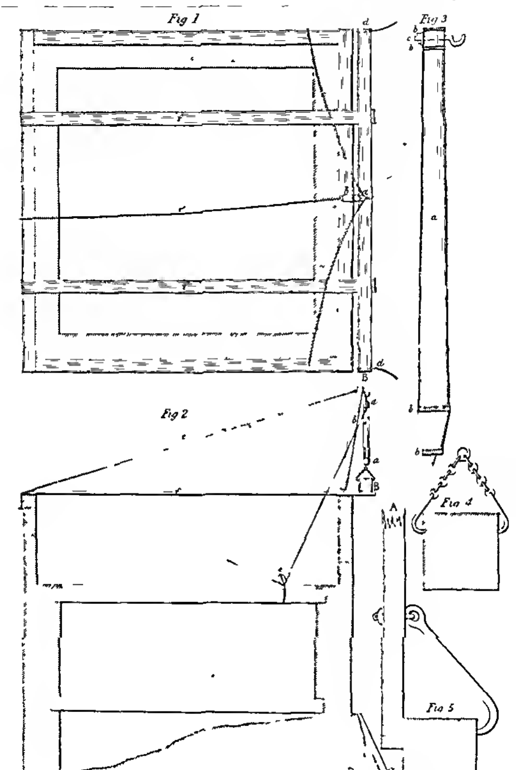
2 *Getting in the Mast, &c*

"The mizen mast is first got in, for which purpose the sheers are placed before the partners or hole (*d*), which the mast is to enter, and the lower purchase block is lashed on a little above the centre of gravity of the mast, that it may have a cant upwards But in preference to this lashing, a stout selvagee made of spun yarn, should be taken round the mast (*a*), the bight put through the strap of the lower purchase block, and a toggle clapped in This, from its pliability, will be sure to hold, and is quickly done.

"Two girt line blocks, one on each side of the mast head (*b*) are lashed, to be ready to get the rigging overhead, and to hoist men on the trestle-trees, in order to place it properly The end of the girt line, which was made fast to one of the sheer heads (*c*) is taken round the mast under the hibbs This is called a *back rope*

* From Darcy Lever pp 17 18

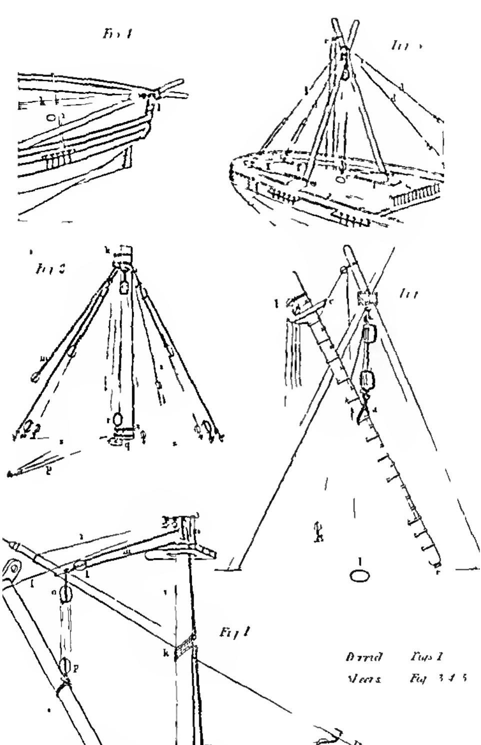
† In Dockyards this is done by either standing sheers on the wharf as at Woolwich or by a sheer hulk as at Devonport The above and following are resources on emergency abroad



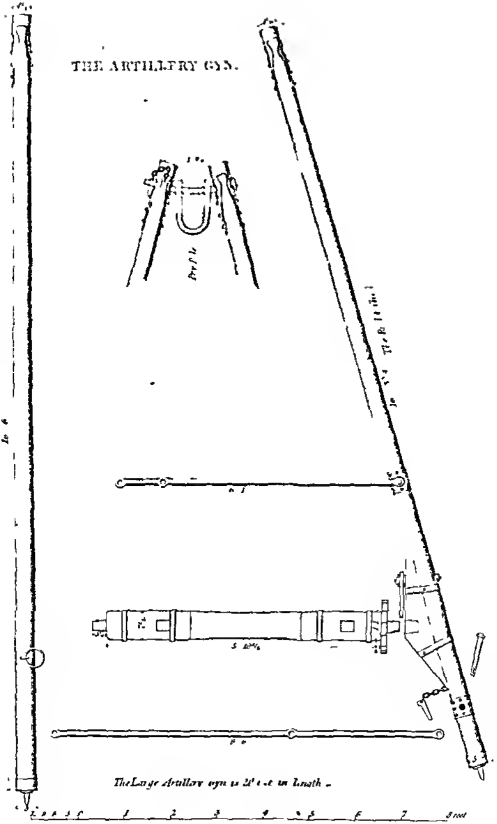
J Simmons R E del.

J. Lowry sculp

John Weale 59 High Holborn 18


Derrick Figs 1
Sheers Figs 3 4 5

THE ARTILLERY GYN.



The Large Artillery gyn is 21 feet in length.

J W Lowry

John Weale 59 High Holborn 1840

"When the mast is high enough, this *back-rope* is hauled upon, which places it in a vertical direction over the partners or hole (*d*). Some hands on deck also assist at the heel of the mast, to make it enter. The purchase fall is then eased, and when fairly entered, they lower away; the people in the hold placing the tenon (*e*) in the heel, into a mortise of a large piece of oak timber, called a *step*, which is bolted on the upper part of the kelson.

"When the mizen-mast is fixed, the sheers are moved forward by the guys and heel-ropes, as seen in fig. 2, and placed before the partners of the main-mast. This and the *fore mast* are got in, and stepped, in the same manner."

N.B. When very large sheers have to be set up from the ground, it will be best done by a pair of small sheers at the head in the first instance, so as to give them sufficient slope for the application of the power by which they are to be raised.

GYN.

Applicable when the weight to be raised is to have little or no lateral motion, as in the Artillery Gyn, Plate III. The 'cheeks' (or front legs) of this, together with the windlass, can also be used as sheers, especially in getting up ordnance on towers, &c., where the parapet is thick enough to allow the gun to rest well upon it when first brought in over the exterior crest, as in most cases the sheers must be set up afresh before they can be used for mounting the gun, or removing it to the interior of the work. The pry-pole is equally available as a derrick, particularly such as shewn in Plate I. Hence the singular value of this engine when well fitted and finished, as combining in itself the capabilities of derrick, sheers, and gyn.

In the Engineer Department this is seldom used, except in such very temporary arrangements for sawing timber as either do not admit of sinking a regular saw-pit, or where the logs lie so widely scattered that it is easier to bring the saw to them than them to the saw. The timber is hauled up between two rough gyns, one at each end, high enough to allow play for the 'pit-sawyer' standing on the ground. It is steadied by lashings, or by resting on cross-bars, which are removed as required, to allow the saw to pass. These gyns need only be of light spars to suffice for very heavy baulk, and require no iron fitments, it being enough to lash the three pole-heads together.

R. J. N.

DIALLING.

In all Dials, the Gnomon represents the Axis of the Earth; hence its angle (L. fig. 2, Plate) with the horizon is the latitude of the place, and it lies in the plane of the meridian.

The hour-lines are the projections of the horary meridians, given by the intersections of their planes with that of the horizon, or dial.

There is a great variety of dials, according to whether they are horizontal, oblique, or vertical, and also depending on their aspect with reference to the sun, but the above principle is common to all; and the Horizontal is the only one that will be here noticed, as being the simple form of which all the rest are only more or less curiously ... borate projections, and also as being by far the most generally useful, at outposts ... other remote places, where there are seldom clocks, and where it is otherwise difficult to obtain even a tolerable approximate to correct time.*

* ...hould the necessary instruments not be at hand, the latitude in the northern hemisphere may ...tained with sufficient accuracy by the careful use of a Gunner's quadrant (or other like simple ...) from the elevation of the Pole star. In the southern hemisphere we have no such

Fig. 1

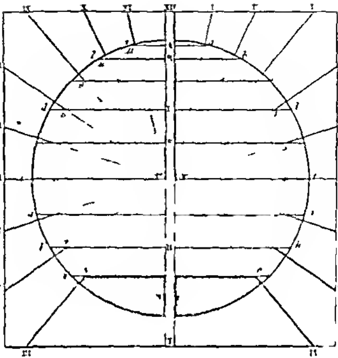
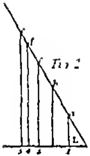


Fig. 2



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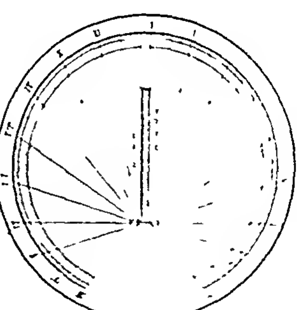
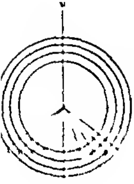


Fig. 4



1 The most convenient of the trigonometrical elements to receive the projections for the hour lines is the 'cosine' of the hour, therefore divide the circumference of the circle into 24 equal parts, *a b*, *b c*, *c d*, &c. for hours, *join a a′*, *b b′*, *c c′*, *to obtain the so called* 'cosines;' and in fig 2 reduce A *a*, B *b*, C *c*, &c, as sines of the angle L (latitude) Apply these sines to the 'cosines' A *a*, B *b*, C *c* (in fig 1), as A 1, B 2, C 3, &c, then the radii from the centre P— P 1 I, P 2 II, P 3 III, &c, will be the required hour lines The like process must of course be followed for half and quarter hours

T, fig 1, is the thickness of the gnomon

In southern latitudes, the P M hours will be on the left of the gnomon, those of A M on the right.

The angle L (fig 2) of the gnomon would in fig 1 be placed at P P′, which neither looks nor answers so well as when the gnomon has a more central position: to effect this the hour circle is advanced, as shewn in fig 3, though the divisions are only continuations of the original projection of the radii, as given on the dotted circle, (repeated for the sake of clearness) as a copy of fig 2

A cylindrical pedestal and circular dial will be found more convenient for adjustment than those of a square or rectilineal form in plan, on these last, once built, the position of the dial plate cannot be corrected without being set awry The width of the gnomon, as given in figs 2 and 3, is not in proportion, when made in copper or brass, it need not be thicker than P P′

MEMORANDUM

In reference to the second paragraph, if the eye is familiarized with the position of the hour lines of the place as given on the sun-dial the watch and pocket-compass, so long as the sun can be seen may be substituted for each other when either may be wanting in a strange or an intricate country in a forest, &c, as a guide to the general direction of one's route, premising that—

A. At 12 A M the Sun must be due South in the northern hemisphere and North in the southern, at 6 A M and 6 P M he must be due East and West respectively, whether seen or not; and at 12 P M, due North in the northern and South in the southern hemisphere,—under which last circumstances, strictly speaking he can only be seen within the frigid zones

B. Also, that at either pole there will be no correction for the hour lines as given in fig 2, as the axis is perpendicular to the horizon; and at the Equator, where the axis is horizontal, the hour lines will be parallel to the also horizontal gnomon

Time, from the Compass

Ex In latitude 60° N., as given in figs. 1, 2 3

The bearings (due) of {	XII	I	II	III	IV.	V	VI	VII	VIII	IX
	XII	XI	X	IX	VIII	VII	VI	V	IV	III
will be respectively . . .	0°	13°	27°	41°	57°	73°	90°	101°	123°	139°

as nearly as may be apprehended by a common compass, the bearings for the upper line being due East —for the lower line, due West Hence, where there is no mag

netic variance but the latitude of the place may be obtained from a good map Under the circumstances as to instruments, the meridian can be laid down by two vertical rods, say 100 yards apart lined on the Pole star; or by dressing one of them on the line given by the same star and some known star. In the southern hemisphere the simplest mode is by bisecting the angles A a a, B b b, &c, given by equal shadows of an upright rod ... on the respective concentric circles A a, &c, drawn on a level surface In all such rude contrivances the operations should be repeated many times and the average of the best results may then be adopted

netic variation, these bearings of the Sun, by compass would point out their respective hours. Suppose, however that this variation is 10° E., the above will become—

XII	I	II	III	IV	V	VI	VII	VIII	IX
170°	3°	17°	31°	47°	63°	80°	97°	113°	129°
XII	XI	X	IX	VIII	VII	VI	V	IV	III
170°	23°	37°	51°	67°	83°	110°	117°	133°	149°

—and these once determined by projection (or else actually taken off by the compass from a sun-dial), and written (like the dial of a watch) inside the top of the compass case will answer nearly enough for a considerable range round the spot for which they were computed considering the rudeness of the operation

Bearings from the Watch

Keeping paragraph A in mind the problem is given the hour and direction of the Sun to find the nearest Cardinal Point

Ex Suppose at 4 P M the direction of the Sun is A S, fig 5, required the direction of the West?

At 4 P M the *due* bearing of P IV (fig 1) is 57° hence looking towards the Sun, its bearing (or that of P′ IV) is 33° (= ∠ IV P′ VI) from the West, and if this be laid off on A S by the eye, or at most by the help of two sticks, as A S A W, the latter will point due West. R. J N

DISEMBARKATION AND EMBARKATION—

Operations necessarily a combination of the *sea and land forces* under the control and superintendence of the former, and hence *disembarkation* and *embarkation* are services forming what are termed conjunct expeditions on a small scale for predatory purposes or on a large scale of operations for conquest or for transporting an army to the theatre of war in a foreign country

In explaining the mode of executing the important duties of disembarkation and embarkation in detail, they are only noticed as combined operations of the two Services land and sea. As regards naval operations alone they will be omitted having no reference to military subjects

The article will be divided into the following Sections

1 Disembarkation and Embarkation of Field Artillery
2 ,, ,, Siege Artillery and Stores.
3 Embarkation of Horses
4 Disembarkation of Infantry
5 Naval Arrangements for ditto
6 General Orders and Instructions of the Officers commanding the Army in Egypt in 1801
7 General Remarks

SECTION I

ON DISEMBARKING AND EMBARKING BATTERIES OF FIELD ARTILLERY *

1 The disembarkation and embarkation of field artillery may take place under circumstances so various, that separate instructions for each mode of proceeding would be endless. The following directions are formed upon general principles which will be found applicable to nearly all the cases which are likely to occur;—such as disem-

* Taken from the Instructions and Regulations for Field Battery Exercises of the Royal Artillery

netic variation, these bearings of the Sun, by compass, would point out their respective hours. Suppose, however, that this variation is 10° E., the above will become—

XII	I	II	III	IV.	V	VI	VII	VIII	IX
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Keeping paragraph A in mind, the problem is, given the hour and direction of the Sun, to find the nearest Cardinal Point

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At 4 P M the *due* bearing of P IV (fig I) is 57°, hence, looking towards the Sun, its bearing (or that of P′ IV) is 33° (= ∠ IV P′ VI) from the West, and if this be laid off on A S by the eye, or at most by the help of two sticks, as A S, A W, the latter will point due West R. J. N

DISEMBARKATION AND EMBARKATION—

Operations necessarily a combination of the *sea and land forces*, under the control and superintendence of the former, and hence *disembarkation* and *embarkation* are services forming what are termed conjunct expeditions on a small scale for predatory purposes, or on a large scale of operations for conquest, or for transporting an army to the theatre of war in a foreign country

In explaining the mode of executing the important duties of disembarkation and embarkation in detail, they are only noticed as combined operations of the two Services, land and sea. As regards naval operations alone, they will be omitted, having no reference to military subjects

The article will be divided into the following Sections

1 Disembarkation and Embarkation of Field Artillery
2 " " Siege Artillery and Stores
3 Embarkation of Horses
4 Disembarkation of Infantry
5 Naval Arrangements for ditto
6 General Orders and Instructions of the Officers commanding the Army in Egypt in 1801.
7 General Remarks

SECTION I

ON DISEMBARKING AND EMBARKING BATTERIES OF FIELD ARTILLERY *

1 The disembarkation and embarkation of field artillery may take place under circumstances so various, that separate instructions for each mode of proceeding would be endless The following directions are formed upon general principles which will be found applicable to nearly all the cases which are likely to occur;—such as disem-

* Taken from the Instructions and Regulations for Field Battery Exercises of the Royal Artillery

e variation, these bearings of the Sun, by compass, would point out their respec- hours. Suppose, however, that this variation is 10° E., the above will become—

XII	I	II	III	IV.	V	VI	VII	VIII.	IX.
170°	3°	17°	31°	47°	63°	80°	97°	113°	129°
XII	XI	X	IX.	VIII	VII	VI	V.	IV.	III
170°	23°	37°	51°	67°	83°	110°	117°	133°	149°

and these, once determined by projection, (or else actually taken off by the compass om a sun dial), and written (like the dial of a watch) inside the top of the compass se, will answer nearly enough for a considerable range round the spot for which ey were computed, considering the rudeness of the operation

earings, from the Watch

Keeping paragraph A in mind the problem is, given the hour and direction of the un, to find the nearest Cardinal Point

Ex Suppose at 4 P M the direction of the Sun is A a, fig 5, required the direc- ion of the West?

At 4 P M the *due* bearing of P IV (fig 1) is 57°; hence, looking towards the Sun its bearing (or that of P′ IV) is 33° (= ∠ IV P′ VI) *from the West*, and if this be laid off on A s by the eye, or at most by the help of two sticks, as A s, the latter will point due West

and all the carriages should be previously embarked, except the guns and limbers, in such proportion as is calculated for the position to be occupied If it be near the water the limbers may also be sent off, and the guns dragged to the boats by men A sufficient supply of ammunition should be at hand in a boat or two close to the shore. If the position be a mile or two from the place of embarkation, it may be necessary to retain a proportion of horses

47 The guns which are last embarked are generally put on board the launches of men-of war, fitted for the purpose, as follows two planks are laid from the bow to the stern, parallel to each other, at the distance of the span of the wheels; a bead is nailed to the inside edge, to prevent the wheels from slipping off Two gang boards, which can be laid out or taken on board, are fitted to the bow ends of the planks, so as to reach from them to the shore as a ramp, and a third one is sometimes fitted to receive the trail of the carriage, by means of these the guns can be run into the boat with the greatest ease. These boats are towed by smaller ones

48 If the enemy be actually present, the embarkation of the last of the troops generally takes place at night

Disembarking when opposed by an Enemy

49 In this case the guns attached to the division of troops which is first to land must be put mounted into the boats fitted as in No 47. It is very desirable that this portion of the artillery should be embarked on board men of war, with the Officers and men attached to them; or if not the whole, at least the non commissioned officers and a few of the gunners to look after the stores; the Officer and the remainder of the men joining previous to the disembarkation. Each two-decker can take a couple; the guns are stowed away on the upper deck, the carriages and wheels in the chains so that the guns can be mounted and ready to be lowered into the boats in a very few minutes The ammunition is to be taken out of the boxes, and placed in the magazine

plank for the trail to recoil upon. The muzzle of the gun, when fired, must be well above the bow of the boat, so as not to shake it. This plan answers perfectly in the flat boats, which, though apparently slight, will stand a round or two very well. These boats are most useful; they are not high out of the water, and stores can be more easily embarked in them than in any others from a beach; but heavy stores are apt to damage them.

SECTION II.

OBSERVATIONS ON THE PROVISION FOR EMBARKING AN EQUIPMENT OF HEAVY ARTILLERY FOR A SIEGE.*

1st. The first things to be considered are, the place to be attacked, its strength, its position, whether distant or not from the spot where the disembarkation is to be effected, the ordinary means of transporting heavy ordnance and stores which the country possesses, and whether such may be calculated on with certainty and made available: all this should be entered upon, to arrive at the nature and extent of the equipment to be forwarded—not only as to the number and nature of ordnance and ammunition, but of the carriages and stores which are essential to complete this equipment in every particular, without encumbering it with burthensome and useless articles which experience and foresight may shew can be dispensed with.

2nd. The particulars of the equipment being thus decided on, one list in detail is to be prepared for the Executive Officer, or Storekeeper of the Ordnance, who is to furnish the supplies,—and the duplicate to the Superintendent of Shipping, who is to provide freight. The burthen, *i.e.* weight and measurement, of the whole equipment should be made out with as much accuracy as possible, so that such ships may be engaged as will give an ample, but not excessive, amount of stowage room. Having thus arrived at the tonnage necessary for the whole, such a distribution should be made as may equalize the *quantities* and *description* of ordnance and stores which each ship should contain, so that in the event of any vessel being lost, there may be no undue deficiency in any one particular respect.

3rd. To arrive with some degree of accuracy at the tonnage required for the conveyance of a large equipment of ordnance and stores, considering the multiplicity of articles comprising it, varying extremely in weight and bulk, it appears to be an object of great importance that the Board of Admiralty should possess what may be called a Tonnage Book, in which should be arranged alphabetically the weight, and measurement in cubic feet, of each piece of ordnance in the Service,—of those carriages, stores, &c., which are known as the indispensable accompaniments of each such piece of ordnance: the like arrangement may be made for Engineer stores. The labour of such a work would be much abridged by considering the various small stores belonging to each gun, &c., as being packed in one or more boxes or cases, of which the bulk and weight should likewise be entered in the Tonnage Book: this would, moreover, enforce a regular system of keeping together the various small stores which belong to each piece, and would thus be immediately available, if necessary, on the latter being landed.

4th. In preparing for the embarkation, considering the Office arrangements as having been made by the allotment to each ship of the particulars which it is intended each shall receive, (their magazines to contain powder being carefully provided and in all respects ready,) whether a single ship or a dozen be necessary to contain the equipment, the plan for adoption which suggests itself to me as best, by combining expedition with accuracy, is as follows:

* By Mr. Butcher, Ordnance Storekeeper, Dublin; and at the Siege of St. Sebastian, 1813.

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50 If the guns are on board transports, the boats may come alongside and the guns be lowered into them as already described The possibility of this occurring shews the absolute necessity of the battery being embarked by its own Officers and men, (see No 3,) when the smallness of the transport s deck and her crowded state must produce great confusion

51. The muzzle of the gun must point forward in the boat, and as soon as the boat takes the ground the gang boards are to be put out, and the gun run on shore which can be done in five minutes in tolerably smooth water At first landing the gun is generally drawn by sailors, an artilleryman guiding it at the trail, and it is therefore better that the limber should accompany the gun which with its ammunition, is then much more easily moved When the limber is not with the gun, the ammunition must be carried by men, which is very fatiguing, the limbers should therefore follow as soon as possible

52 The artillery should endeavour to gain the shore, and land with the troops whose object will be to take up a position to cover the landing of the main body, and a sufficient supply of artillery ammunition and stores, in the common deal laboratory boxes, should be in a boat or two close to the shore The landing is generally covered by the smaller frigates and by boats fitted with carronades.

53 By removing some of the forward thwarts of the boat, the planks for the gun-wheels can be laid with a slope, and one gun in a boat be fired to cover the landing, this slope should be about 3 inches to a foot, which will diminish the recoil to 1½ foot From these, two short planks should be laid, leading to the gang boards, these may be fixed or they may be laid after running the gun back, there must also be a centre

plank for the trail to recoil upon. The muzzle of the gun, when fired, must be well above the bow of the boat, so as not to shake it. This plan answers perfectly in the flat boats, which, though apparently slight, will stand a round or two very well. These boats are most useful, they are not high out of the water, and stores can be more easily embarked in them than in any others from a beach; but heavy stores are apt to damage them.

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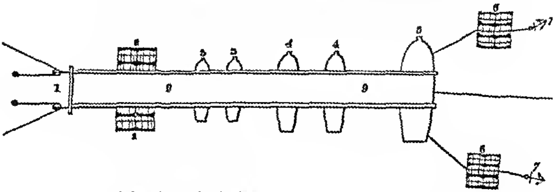
* By Mr Butcher Ordnance Storekeeper Dublin and at the Siege of St Sebastian 1813

See Bridge' Plate VIII

It is conceived that for the purposes of landing troops and stores, a *half* of a bridge similar to some of those described in Sir Howard Douglas's work on Military Bridges might be constructed from the boats of a line-of battle ship thus



1 Bridge end fastened to the shore

2 Raft of casks in the shallow water the end next the beach to be protected with *fenders* of bags of oakum or fascines to prevent the heave of the sea from staving the casks by thumping them against the bottom

3 Ship's cutters

4 Pinnace and barge

5 Launch

6 Two rafts of casks capable of bearing about say 6 tons each *have partly under water* so as to act as a *spring* on the bridge and keep all taut, and also *to prevent a downward strain* on the outer boat these rafts bringing the strain parallel to the surface of the water

7 Heavy anchors with a long scope of cables say 100 fathoms each of 8-inch hawsers

8 Anchor for hauling out the bridge on the fall of the tide so as to keep the raft at the inner end always afloat this hawser to be slacked up when a vessel goes alongside the bridge end

9 Two-inch deals 10 feet long laid on five 6 inch hawsers To form the roadway of the bridge the planks must be 2 inches apart to allow the sea to wash between them and prevent their being blown up

Oars boats masts and small spars should be laid *running* the whole length of the bridge, lashed over the ends of the planking to the hawser beneath, to prevent too much spring in the bridge

Such a structure from its being very *flexible* would it is supposed stand a considerable sea

Small steamers might go alongside the end of it, while boats could put men on its side

ADVANTAGES

Fifteen feet of beach or rock is all that would be required small spots therefore might be selected for a landing where the enemy had no troops Generally wherever the beach is extensive for a landing a strict watch would be kept but it is impossible to watch every small nook of from 10 to 30 feet landing place

Such a structure might be put together out of gun-shot, and towed in; with proper drilling half an hour would probably anchor it and secure all taut

In re-embarking there would be no danger of the boats becoming hard and fast ashore on their being loaded which sometimes takes place now and men are at times obliged to land again to get a boat afloat.

In re-embarking under fire the rear guard might run on the bridge and cut it away, and take their chance of being towed out of range by a steamer

With such a structure, a force would land in one-tenth of the time now requisite to land them in boats.

When one of Blanshard's large bridges is embarked and is not immediately required for operations on shore it might be thus used.—*Ed.*

SECTION V.

FRAGMENTARY NOTICES OF NAVAL ARRANGEMENTS FOR DISEMBARKING TROOPS.*

In landing without opposition advance in line abreast with as few men in the bow of the boat as possible which will enable her to be laid high on the beach and prevent the men from getting wet.

When opposition is expected the troops intended to be landed from men-of-war or transports in an enemy's country should have on the previous night three days provisions ready cooked and served out as they are leaving the ship. When in the boats they should rendezvous at the nearest ship in shore, when ready, advance in line covered by the launches and all other boats carrying guns and flanked by frigates and brigs as the water will allow. A Subaltern's party should be named to advance to an height to observe what is going forward while the battalion is forming which

required.

Any number of soldiers that can be conveniently carried without lumbering the oars or loading the *bow* may be stowed in the boats.

All boats should be provided with two buckets for baling in the event of their being struck by shot in which case a tallow plug or a seaman's jacket should be quickly placed in the hole. Should there be extra ammunition in the boat it should be removed into the stern sheets and kept dry.

When the launches and pinnaces, &c. are entirely filled with troops they should be towed by as many *small* boats as can be spared from the fleet.

Each boat should be furnished with two planks that would stow between the after thwart and head sheets, or if this cannot be done let them be slung over the gunwale. These planks when nailed to a batten on each end will enable the soldier who at all times is heavily laden to have confidence to embark or otherwise without wetting himself.

All men of war boats have gang boards which will answer when you cannot get broader ones.

LANDING ON SURF BEACHES.

Troops cannot be landed in a heavy surf without great risk. The boats of the country where the service takes place will answer better than our own (perhaps) and if they do I should take the liberty of borrowing a few for a short time.

But I should push for a river or get within a reef if possible. Beaches defended by surfs are generally accessible before sun rise in *moderate weather*. You can land at Madras between 4 and 5 A.M., by 10 you could only approach it in a Masula boat.

On these beaches there are generally running three heavy surges, if you place your boat on the back of the last and let the men *pull for their lives* you may reach

* Gleaned from the correspondence of an old Naval Officer.

account of the impossibility of defining precisely what is to be done in regard to embarking and disembarking troops under fire,—these operations depending upon local circumstances, and because that, before orders can be issued, a careful reconnoissance must be made of the place proposed for the point of embarkation and disembarkation,—how it is protected,—how near it can be approached with vessels of light draft of water to scour the beach and cover the boats,—what description of boats are at command,—the number of men to be landed and taken off, &c.*

But assuming that these preliminary questions are provided for, the details and precise arrangements for the embarkation and disembarkation of *troops and stores* are desirable; therefore, in order to give every information possible, the best authorities attainable have been selected, as given in the preceding Sections.

For ordinary circumstances, and every day occurrence to British soldiers in their tour of foreign and colonial service, the Queen's Regulations should be consulted, commencing at page 325 and ending at 369, third edition.

The introduction of steam to maritime war affords facilities of transport, and the means of covering a landing or re-embarkation, not available before; but these additional means do not give the actual operations any greater facilities than before, as the men and stores are still to be placed in boats adapted to the local circumstances.

For distant operations, the long boat of the transport and the launch, barge, and pinnace, are the only resources which have hitherto served the purpose; and flat bottom and other boats constructed expressly for the landing of troops are difficult to carry, and rarely found at the point of debarkation.

The British soldier, after a few weeks afloat, acquires a certain degree of handiness, and what is termed his 'sea legs;' he will then profit by the hints offered in Section IV. *of this article, written by Captain Rea, of the Royal Marines.*

The landing in Egypt in 1801 is given in Section VI. as an example of a debarkation of a large force, as extracted from Sir Robert Wilson's 'History of the British Expedition,' fourth edition. The force landed was probably the largest (5000 men) ever

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* The following memoranda for reconnoitring previous, or for report subsequent, to a landing may be useful and acceptable.

CÔTES.

"La nature des côtes, bordées de dunes, couvertes de rochers plats qui rendent leur abord plus ou moins dangereux, hérissées de falaises qui en interdisent absolument l'accès—les parties développées et découvertes propres aux descentes—les parties rentrantes offrant des anses et des ports—les pointes et les caps propres aux forts, aux batteries, qui pourront défendre les points accessibles—les îles adjacentes servant d'ouvrages avancés qui forment des barrières aux tentatives de l'ennemi—les lagunes—les anses—les baies—les rades—les ports; la nature des vents qui sont nécessaires pour l'entrée et pour la sortie de ces ports, dont il faut indiquer les avantages et les inconvénients—les

. . . .

gardes—côtes, en attendant que les troupes réglées de tels et tels lieux puissent arriver aux points attaqués.—S'il est des rivières qui aient leur embouchure sur ces côtes, *les marées apportent des* variations sur leur passage, il faut rendre un compte exact de cette influence."—*Aide Mémoire à l'usage des Officiers d'Artillerie de France.* Tome second. 5th ed. p. 1152.

thrown on shore at one time, and the whole of the arrangements appear as perfect as they were successful, and serve as a beautiful study for similar operations

In reviewing the important points embraced by this subject, and recapitulating the Sections of this article, which comprise, as regards *Embarkation*,

First, the deliberate and careful stowing of the Artillery, Engineer, and other stores, to be placed in the vessels in the order of probable wants, and so as easily to be got at, as explained in Sections I and II,—

Secondly, the embarkation of the horses and troops,—

Lastly, the economy and management of the whole afloat, which are especially provided and explained in the Queen's Regulations,—

In the *Disembarkation*, the horses and troops become the first for consideration: the men to be placed in boats, the horses swum to shore, and a few pieces of light artillery dragged on in the first instance by seamen otherwise the first operation in embarking is the last in the disembarkation the final one will, of course, depend upon the Objective Points of the expedition to be attained G. G. L.

DISINFECTION.—See 'Sanitary Precautions'

DIVING BELL *

DESCRIPTION OF THE DIVING BELLS AND MACHINERY, &c USED IN THE ERECTION OF THE NEW PIER AT HOBBS' POINT, MILFORD HAVEN †

There were four bells employed, which I shall describe separately, as they all varied either in size, shape, or material.

Diving Bell figs 1, 2 3, and 4 —No. 1 diving bell was made of cast iron 6 feet 2 inches long 4 feet 6 inches broad at the bottom (on the outside), and 5 feet 2 inches high, the sides and ends were 1½ inch thick at the top and 2½ inches thick at the bottom, the top of the bell was 1½ inch thick, and strengthened by a strong longitudinal iron rib, to which the block of the fall was shackled there were also six transverse ribs, three on each side of the longitudinal one This bell was not quite flat at the top but rose 3½ inches from the sides towards the centre, and was cast in one piece, it weighed 4½ tons On the top were ten convex lenses, 8 inches in diameter fitted into a rabbet formed in the casting, having an iron rim screwed round them on the inside of the top of the bell to secure them these lenses admitted sufficient light, when the water was clear, to distinguish the smallest objects (which I have been enabled to do when in the diving bell 54 feet under water).‡ Air was supplied to the workmen employed in it through a leather hose, one end of which was screwed into the centre of the top of the bell, and the other into the receiver of an air pump worked from above The hole that admitted the air was covered on the inside of the top of the bell with a piece of circular leather, secured by eight screws, in the spaces between which the air entered and spread avoiding thereby an unpleasant direct current. This piece of leather, should the hose burst, would also prevent any very great quantity of water from entering the bell instantly, and there was always sufficient air in it to support the workmen till they could be raised to the surface On the outside of the bell, at each

* From 'Professional Papers,' vol I

† By Lieut Colonel Savage R E

‡ The foundation-stone of the pier is 57 feet under water at the highest spring tides

Fig. 7.—Elevation of Air-pump.

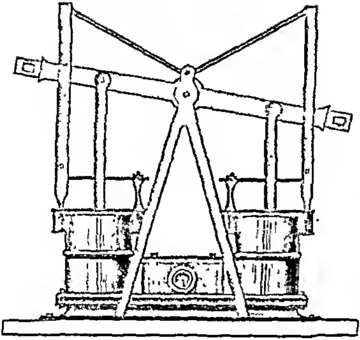
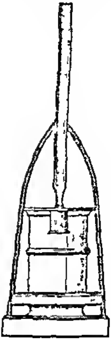


Fig. 8.—Side Elevation of Air-pump.



In these sketches of the air-pump the part left unshaded is brass.

Hose.—The hoses were made of cow-hide double,* nearly a quarter of an inch thick, between which there was a layer of coarse duck, well rubbed over with currier's dubbing; the leather was tongued at the seam, the edges thinned, turned down, and stitched through the whole. The hoses were made in lengths of about 18 feet, which were joined together by a brass male and female screw; they required to be well greased every two or three weeks with a mixture of tallow and bees'-wax; in cold weather, the quantity of the latter article was very small, but in summer more was required, to give solidity to the composition. The diameter of the hose was about 2½ inches: if well made and taken care of, one would last five or six years.

The hoses when in use ought to be supported at the joints by small lines, in order to prevent their being strained.—*See* elevation of diving bell and machinery.—Plate I.

Crab, &c. (Plate II.)—Each bell was suspended from a cast-iron crab, mounted upon a small wooden carriage having four cast-iron wheels attached to it; over the two front ones, small pinion-wheels were placed, which were turned by a short iron bar being inserted into holes made into them for that purpose: by this means the bell was moved with the greatest facility from the front to the back of the wall. The wheels of the crab-carriage moved on a rail-road fixed on the top of a large carriage upon which they were placed. One end of the bell-fall was fastened to the frame of the crab-carriages, and the other to the barrel of the crab, passing through a double block at the top and a treble one at the bottom. The lower block was secured to

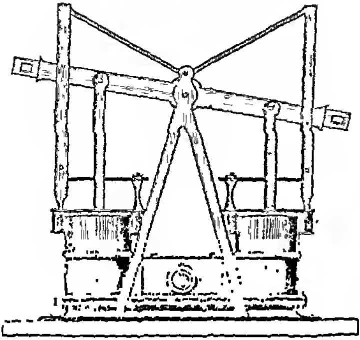
* Gutta percha is now the suitable material.—*Editors*

the diving bell by strong chains, which were run through three strong iron shackles, one of which was bolted to the lower block, and the other two to each end of the longitudinal rib on the top of the bell The fall was a 7-inch shroud layed rope in six parts. Two men were sufficient to raise or lower the bell when it was under water, but it required six or eight to raise it when out or coming out. A crab and carriage, similar to the one to which the bell was attached, was used for lowering down the large blocks of granite and limestone.

Stage.—The stage from which the diving bells were worked embraced the whole *width* of the pier-wall, erected with piles from 60 to 75 feet long and from 14 to 15 inches square: they were pointed and shod with iron at the bottom, and had also large flat stones bolted to them, by which means they were more easily fixed in their proper places. The outer and inner rows were 23 feet 6 inches apart in the clear at the top The piles battered about ⅓th, and were placed from 10 to 12 feet from each other The string pieces upon which the rail road was laid were about 40 feet long (each length) and from 14 to 15 inches square, secured to the piles by screw bolts and nuts The string pieces were supported by strong cleats under them, which were nailed and screwed to the piles, they were also further secured by an iron band. The level of the rail road on the stage was 9 feet 6 inches above high-water spring tides A gang board, 15 inches wide, was fixed on the outside of the string pieces, for the workmen to walk on. Strong struts were fixed against the outer and inner rows of piles, and the stage was secured to the shore by iron chains, which could be tightened by screws when required. The front and back parts of the stage were connected together by cross pieces of timber (14 inches × 7 inches), bolted down to the string pieces, underneath them cleats were nailed, for the purpose of steadying the stage, and keeping it apart these cross pieces were occasionally shifted one was always placed at each end of the part of the work where the diving bell was employed, a space generally of from 30 to 40 feet in length At different parts, along the stage, sheds were erected in which the air pumps were placed, and also a small windlass, by which the box containing the rock and shingle that had been excavated by the workmen employed in the diving bell was drawn up and the contents emptied into a barge stationed to receive it By similar means spalls and mortar were lowered down to the masons who were building in the bell A boat was always in attendance, in which there was a supply of mortar and small stones, &c kept in readiness, and also a labourer to empty and fill these boxes A small line was attached to them, by which means they were pulled into the bells by the workmen The floors of the pump-houses were about 6 feet above high water, and as the tops of them abutted against the string piece of the stage, and were level with it, their roofs were found very useful for laying on them many small articles required by the workmen employed on the stage: the mortar box had a cover to it The roads by which the large stones were brought from the shore to the stage were formed by two baulks about 14 inches square, laid parallel to each other, 3 feet apart, having a gentle slope towards the front wall of the pier, by which means the truck upon which the stone was placed was easily pushed forward by one man, as a rail road was laid upon the baulks one end of them rested upon a strong piece of timber, which was spiked to two of the inner row of stage piles, and the other end on the bank on the shore the centre was supported by uprights These roads were from 60 to 80 feet long a piece of wood was nailed across the outer end of them, to prevent the truck from running over

Bell Vessel.—The diving bells at Hobbs' Point were at first worked from a schooner of about 120 tons a stage having been erected across her deck, projecting over each side, from thence the bells were suspended from crabs placed on the stage

Fig. 7.—Elevation of Air-pump.



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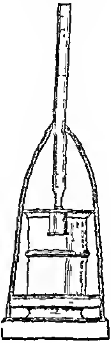

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Bell Vessel.—The diving bells at Hobbs' Point were at first worked from a schooner of about 120 tons: a stage having been erected across her deck, projecting over each side, from thence the bells were suspended from crabs placed on the stage

A shovel with a short handle
Two signal hammers.
A pair of lewises
Two chains, a large and a small one, a swab, a piece of chalk, a trowel, and foot rule.

The miners in the bell employed in excavating shingle, rubble, and rock, required the following tools, viz.

A crow-bar, 3 feet long
A miner's pick with a short handle
A shovel
A sledge hammer.
Two signal hammers
Several gads of different lengths and sizes, a swab, and a piece of chalk Tin tubes, powder, and borers, were taken down by the workmen when wanted

Manner of working the Diving Bells.—The bells were at first, for a few months, worked from a vessel of about 120 tons, but from its being found very inconvenient, a stage (as before described) was erected, on the top of which was a strong wooden carriage, mounted on four iron wheels, traversing on a rail road from one end of the stage to the other (which extended the whole length of the front wall of the pier, 200 feet), on this carriage another rail road was laid, on which was placed a crab and carriage, and to it the diving bell was attached by this means it could be moved wherever required, with the greatest ease In the summer, the bells were employed from 5 o'clock in the morning till 7 o'clock in the evening, the remainder of the year, from daylight till dark The principal directions necessary to be given for carrying on the work in the bells were communicated by the men employed in them to the superintending foreman (who was constantly stationed on the stage), by striking the side of the diving bell with the signal hammer a certain number of strokes, each having a particular signification, of which the following is an explanation, viz.:

One stroke, signifies that they require more air			
Two strokes, to let the bell remain as it is			
Three	,,	to raise it	
Four	,,	to lower it	
Five	,,	to move the bell to the front of the wall.	
Six	,,	,,	to the back.
Seven	,,	,,	to the right
Eight	,,	,,	to the left.

All other communications were made by writing them with chalk on a small board painted black, to which a line was attached, reaching from the bell to the stage, which was pulled up by the workmen when they wished to send up a message there was a small chain about 5 or 6 feet long, fixed to the lower end of this line, or otherwise it would soon have worn out by rubbing against the bottom edge of the diving bell when drawing the message board up and down

A carriage and crab similar to those used for the bell was employed for lowering the large stones to the workmen and the small stones and mortar were sent down to them in a small box. A labourer was stationed in a barge, who attended upon two bells, either to receive what the miners excavated, or to supply the masons with materials.

The following was the distribution of the men attached to each bell, having a foreman to superintend the whole of them

Description of Workmen	The Number of the Diving Bell and how employed						Occupation of the Workmen
	Nos 1 and 2.—Building			Nos 3 and 4.—Excavating			
	For No 1	For No 2	Remarks	For No 3	For No 4	Remarks	
Masons . .	1	1	. . . . . .	2	2	Labourers .	Employed in the bell.
	1	1	For a relief .	. . .	. . .	. . . . . .	Above, selecting stones
Labourers .	1	1	. . . . . .	1	1	. . . . . .	Attending guy rope.
	2	2	. . . . . .	2	2	For a relief .	At the crab
	5	5	. . . . . .	4	4	. . . . . .	Working the air pump
	. . 1 . .		. . . . . .	. . 1 . .		. . . . . .	In the boat attending
Total Workmen	21 for two building bells			and 19 for the two excavating			

One foreman superintended the *four* bells, when more hands were required to work the air-pump, one of the men stationed at the crab assisted.

The masons attached to the diving bells, when not down in them at work, were employed on shore in preparing and selecting such stones as were required, and the labourers were stationed either at the crab or guy rope. At high water, five or six men were necessary to work the air pump, one only being then left at the crab The foreman had the entire direction and distribution of all the workmen attending the diving bells, no man was allowed, upon any occasion whatever, to *leave* his post without his permission His particular duty was also to pay the greatest attention to all signals At low tide, if the bells were not in deep water, two or three men were quite sufficient to work the air pump The workmen employed with the diving bell *were not allowed any regular hour for breakfast or dinner, but took their meals by* turns, at whatever time they could best be spared for a short period from their work. In the summer, the men working at the bells were relieved three times during the day, viz the first party went down at 5 o'clock in the morning, the second relieved the first at 10, and the first relieved the second at 2, and *they* remained down till 7 in the evening, at which hour they left work by this arrangement one party went down in the bell twice one day, and once the next, alternately, in the winter, on account of the shortness of the days, the men employed in the diving bells were only relieved once, viz. at 12 o'clock the average time, therefore, that the workmen were down in the bells was about $4\frac{1}{2}$ hours, both in summer and winter, each spell. The reason an additional man was allowed to work the air pump attached to the building bell was, because it was moved about oftener, and also required to be kept more *free* from water.

The *following* were the rates of pay the workmen received who were employed in the diving bells at Milford Haven:

	Masons		Miners		Labourers.	
	s	*d*	*s*	*d*	*s*	*d*
Pay per hour when down working in the bell .	0	8	0	7	0	6
Pay per hour when relieved and employed above .	0	3	0	2	0	2
Daily pay during summer, working fourteen hours per diem, viz seven hours in the diving bell, and seven hours above	6	5	5	3	4	8
Daily pay during winter, working eight hours per diem, viz four hours in the diving bell, and four hours above	3	8	3	0	2	8

The foreman in charge of the bells had £1 5*s* per week constant pay, both winter and summer

The labourers employed at the air pump received 2*d* an hour during summer, and 1*s* 8*d* per diem during winter, they never worked in the diving bell The common wages at Pembroke were 2*s* 6*d* per diem for artificers, and 1*s* 8*d*. for labourers

General Observations on Bell work.—From the improvements made in the construction of diving bells, and the facility with which the workmen can be furnished with an ample supply of air by the air pump, any description of work may now be executed by their means, *and with very little difficulty or danger* Having for the space of four years been constantly in the habit of going down in the diving bells employed in the erection of the landing wharf at Hobbs' Point, Milford Haven, for the purpose of inspecting and measuring the work in progress I am fully satisfied that building may be performed under water with an equal certainty as above, but the greatest possible care must be constantly paid in carrying on the work, to insure which, it is essentially necessary that a very steady attentive man should have the entire direction of all the people attached to the diving bells, who will also pay the strictest attention to all signals made by the workmen employed down in them, and by whom the whole of the machinery, gear &c., (*particularly the fall*) should carefully be examined every morning, and a written report given that he had done so to the Officer superintending the work The greatest inconvenience experienced by the men working in the bells was the pain produced in the ears from the pressure of the condensed air on the drum, which occasionally, when in very deep water, brought blood from them, and also from the nose: this, however, rarely happened and as a proof that they did not suffer any very great inconvenience, one man only ever quitted bell work from choice, and several were employed in them from the commencement to the completion of the work, a period of upwards of four years. The workmen in the diving bells always wore thick flannel frocks and breeches, and high mud boots well greased and most of them flannel or worsted caps. From the depth of water at high tide (especially during the winter months), and from the heavy rains, it was so muddy that candles were obliged then almost constantly to be used, when it was found necessary to have an additional man at the air pump. From the greatest attention to the signals made by the workmen employed in the diving bells, and a constant examination of the machinery and gear, not the most *trifling accident* occurred during the whole period the bells were in use; but I feel it my duty to state (as a warning), that a most serious one would most probably once have happened, had the bell not been in very deep water at the time, in consequence of the small line attached to the message board getting between the cheeks and sheave of the lower block, and thereby for a short time jamming the fall, and as the bell was lowering down, several yards of it became slack, therefore, when the line got disengaged from the block which it soon did the diving bell suddenly fell at

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	2	2	. . . . . .	2	2	For a relief .	At the cra
	5	5	. . . . . .	4	4	. . . . .	Working
	. . .	1	. . . . . .	. . .	1	. . . . .	*In the*
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DIVING DRESS AND APPARATUS.*

For the removal of wrecks, shoals, enlarging entrances to harbours,† making submarine surveys &c., where so much of the diver's success depends upon his being able to extend his operations over a large space of ground, the Diving Dress possesses many advantages over the Diving Bell, as the latter, although very useful in building under water, affords so limited a space for working that it much impedes the operations of a diver when employed on either of the above named objects. Thus, for general purposes, the diving dress is preferred to the bell, and it has been a desideratum to ascertain the best form to be given to it, so as to preserve the health, and endanger as little as possible the safety, of the men employed.

Mr Deane appears to have been the first person known to have used the diving dress, or at least to have turned it to any practical utility. His apparatus is exceedingly simple, and is usually styled the 'Open Dress,' on account of the metal helmet (which covers the head and breast of the diver) being separate and unattached to the lower part or body of the dress. The latter is made of stout Macintosh cloth, and forms a complete water proof covering to the body from the feet to the neck: here, as well as at the ends of the sleeves, there are openings left sufficiently large for drawing the dress over the person, and for passing the hands through, which must be left exposed to enable the diver to work properly: these ends are tightened round the wrists by linen wrappers, while the upper opening is plaited, and loosely drawn in round the neck, and confined there by a handkerchief or band. The metal helmet, with a loose canvas jacket attached, drops down over the head upon the diver's shoulders, being prevented from coming off by weights suspended from it, resting against his breast and back. The helmet on this principle becomes a small portable diving bell carried about by the diver while at the bottom, and the circumambient water is at the same time prevented, by the dress, from getting to his person. An air pipe leads from the back of the helmet to the surface, and when a proper supply of air is delivered from the air pump above, the water will be perfectly excluded from the helmet down to about the level of the neck: the collar of the dress should come up as high as the diver's ears, so that any water accidentally rising higher, from air imperfectly supplied or other causes, may be prevented, as much as possible, from flowing over the collar and wetting his person,—a circumstance attended with most injurious effects to health, and necessarily retarding the operations. It should be remarked, that with Mr Deane's apparatus the diver must always keep his head as nearly as possible upright; in stooping or lying down with the head out of that position, the water will have a tendency to rise in the helmet and flow over the collar, and if by accident he should fall down head foremost, or become entangled with the head downwards, he would certainly be drowned, unless speedily extricated and hauled up. This is a great inconvenience, as most divers prefer the stooping or creeping posture while working to any other, and it becomes troublesome and painful to keep the head erect while the rest of the body is not so. On the other hand, divers remark that the air they breathe is much purer while working in this dress than in what is called the 'Tight or Close Dress,' which will presently be described, on account of the freedom with which the waste or foul air can escape from a helmet open at the bottom.

The inconvenience, and even danger, attending the use of the open dress which is

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* By the late Capt. Hutchinson R.E.

† Helmet divers were regularly employed in enlarging the entrance to St. George's harbour Bermuda.

least 10 feet the jerk thereby occasioned was not felt much, as the bell most fortunately was then in very deep water, otherwise it would most probably have broken the fall, and proved fatal to the two men that were in the *diving bell* *To prevent* the possibility of this happening again, I immediately had three straps of leather, about 2 inches wide, nailed across the cheeks of all the lower blocks, which I recommend always being done.

W J S

As Officers may be often thrown into situations where, although advisable to use a diving bell, it may be impossible to procure a cast-iron bell of sufficient dimensions, the following account of a wooden bell, extracted from the 'Transactions of the Institution of Civil Engineers,' may perhaps prove useful

DESCRIPTION OF A WOODEN DIVING BELL EMPLOYED BY MR RENDEL IN THE CONSTRUCTION OF THE LARY BRIDGE, NEAR PLYMOUTH

The interoal dimensions of the bell were 5 feet 6 inches in length, 4 feet 6 inches in width, and 5 feet in height the sides, ends, and top were made of two thicknesses of $1\frac{1}{2}$ inch well seasoned elm board, the inner case was constructed with its joints parallel to the top and bottom, or mouth of the bell, whilst those of the outer case were vertical, or at right angles to the inner joints, the top joints were crossed in the same manner as the sides, all the joints had a slip of flannel saturated in a composition of bees' wax laid between them and *were dove tailed together*, and *set as close* as possible by means of screw clamps, &c the sides were rabbeted to the end, and the internal angles strengthened with brackets The whole surface between the inner and outer case was covered with double flannel, saturated as just described, and was then connected together by a number of wooden pins dipped in tar, and tightly driven the top was perforated with six holes, of 6 inches diameter each, in which were firmly fixed a corresponding number of strong lenses set in white lead, a hole of 3 inches diameter was made in the centre, in which was fixed a brass pipe with a screw to attach the air tube four hoops of wrought iron, two internal and two external, were screw bolted together, through the sides and ends of the bell, internal and external cross lacings were also screw bolted to those hoops, and to the sides and top of the bell, in these lacings, the chains by which the bell was suspended were fixed in strong iron eyes, which passed through the top of the bell, and were riveted to the inner lacings All the screw bolts were driven with tarred oakum, and every precaution was taken to render the whole air tight The bell, thus finished, weighed [illegible]

sank with steadiness in about 25 feet water The bell was provided with two moveable seats and a foot board for the divers, and at top long boxes were fixed, in which their tools were kept, it was provided with air by a double acting force pump, the cylinders of which were 7 inches diameter in the clear, making a 14 inch stroke *This pump was generally worked by four men, and made on an average, according to the* depth of the water and run of the tide, about eight double strokes in a minute

This bell was mounted and worked upon a carriage and platform similar to that described by Lieut Colonel Savage

W DENISON, R.E

DIVING DRESS AND APPARATUS.*

For the removal of wrecks, shoals, enlarging entrances to harbours,† making submarine surveys, &c., where so much of the diver's success depends upon his being able to extend his operations over a large space of ground, the Diving Dress possesses many advantages over the Diving Bell, as the latter, although very useful in building under water, affords so limited a space for working that it much impedes the operations of a diver when employed on either of the above named objects. Thus, for general purposes, the diving dress is preferred to the bell, and it has been a desideratum to ascertain the best form to be given to it, so as to preserve the health, and endanger as little as possible the safety, of the men employed.

Mr. Deane appears to have been the first person known to have used the diving dress, or at least to have turned it to any practical utility. His apparatus is exceedingly simple, and is usually styled the 'Open Dress,' on account of the metal helmet (which covers the head and breast of the diver) being separate and unattached to the lower part or body of the dress. The latter is made of stout Macintosh cloth, and forms a complete water proof covering to the body from the feet to the neck: here, as well as at the ends of the sleeves, there are openings left sufficiently large for drawing the dress over the person, and for passing the hands through, which must be left exposed to enable the diver to work properly: these ends are tightened round the wrists by linen wrappers, while the upper opening is plaited, and loosely drawn in round the neck, and confined there by a handkerchief or band. The metal helmet, with a loose canvas jacket attached, drops down over the head upon the diver's shoulders, being prevented from coming off by weights suspended from it, resting against his breast and back. The helmet on this principle becomes a small portable diving bell carried about by the diver while at the bottom, and the circumambient water is at the same time prevented, by the dress, from getting to his person. An air pipe leads from the back of the helmet to the surface, and when a proper supply of air is delivered from the air pump above, the water will be perfectly excluded from the helmet down to about the level of the neck: the collar of the dress should come up as high as the diver's ears, so that any water accidentally rising higher, from air imperfectly supplied or other causes, may be prevented, as much as possible, from flowing over the collar and wetting his person,—a circumstance attended with most injurious effects to health, and necessarily retarding the operations. It should be remarked, that with Mr. Deane's apparatus the diver must always keep his head as nearly as possible upright; in stooping or lying down with the head out of that position, the water will have a tendency to rise in the helmet and flow over the collar; and if by accident he should fall down head foremost, or become entangled with the head downwards, he would certainly be drowned, unless speedily extricated and hauled up. This is a great inconvenience, as most divers prefer the stooping or creeping posture while working to any other, and it becomes troublesome and painful to keep the head erect while the rest of the body is not so. On the other hand, divers remark that the air they breathe is much purer while working in this dress than in what is called the 'Tight or Close Dress,' which will presently be described, on account of the freedom with which the waste or foul air can escape from a helmet open at the bottom.

The inconvenience, and even danger, attending the use of the open dress, which is

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* By the late Capt. Hutchinson, R. E.

† Helmet divers were regularly employed in enlarging the entrance to St. George's harbour, Bermuda.

OF THE AIR PIPES

The air pipes are usually formed of an outer casing of solid sheet India-rubber, about ¼ inch thick, stiffened internally with spiral wire, the bore or opening for air being left about ¾ inch diameter in the clear; thus the total diameter of the pipe on the outside will be from 1¼ inch to 1½ inch; it must be entirely covered with canvas to protect the India-rubber from friction in descending to the bottom, the part remaining above water should be carefully coiled away in a tub, and any portion which may have to lie along the deck of the vessel or on the ground should also be covered by lengths of wooden trough, about 2½ inches or 3 inches square to prevent the workmen from treading on it. Too many precautions cannot be taken to keep the air pipe from being injured, as upon this the safety of the diver in a great measure depends. The wire used for stiffening it should be of copper or gun metal. Pipes of inferior manufacture are sometimes stiffened with iron wire tinned over, but these should be rejected as unfit for use, for the moisture will cause the wire to rust, which will then soon become broken, and by degrees cut through the India-rubber; a fracture may then be caused in the pipe, which would be attended with serious consequences to the diver, if it occurred while he was at the bottom; for as in such a case the air thrown into the pipe would escape before it reached him, the equilibrium of pressure would be destroyed, and the surrounding water would act upon his person with a pressure due to the depth at which he might happen to be working, or, at a depth of 90 feet, to three atmospheres.

Some instances of this have actually occurred where the body has been as it were so squeezed and compressed by the weight of water, that the blood has been forcibly driven into the vessels of the head and neck, causing a state resembling asphyxia and disabling the diver for a month or six weeks; fortunately none of these cases though very alarming, have terminated fatally.* To guard against such frightful accidents, every diving apparatus should be provided with a safety valve opening downwards, to be screwed on between the end of the pipe and the helmet. The air on being forced in from the pump opens the valve and allows it to pass into the dress, but on this pressure being removed, the valve closes and prevents any of the air already in the dress from escaping back through the pipe, and the quantity of air thus enclosed within the dress would be quite sufficient to support life for several minutes, or for a much longer time than would be required to haul a man up from the bottom.

The air pipes are made in lengths of from 30 to 40 feet, with union screw joints to each, so that they may be screwed up without twisting. They should be proved [illegible] that they are perfect throughout, by closing one end [illegible] ndensation that [illegible] ge fitted [illegible] to the pump.

It should be remarked that diving operations may be carried on at [illegible] ing half a gale of wind, for when about 6 feet below the surface divers feel little or nothing [illegible] them; the principal inconvenience they have to [illegible] vessels from [illegible]

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* [illegible] were suffered in this manner in 1841 and 1842 [illegible] George at [illegible] power [illegible]

References to Plates

Plate I

Fig 1 The diver in his dress, supposed to be at the bottom of the sea

A Air pipe, screwed on to a nozzle at the back of helmet, confined by a belt round the waist, and led up under the left arm to the surface

B. Breast or life line passed under the arms, partly concealed by w, the front weight of about 43 lbs, with a similar one at the back

K Knife in waist belt, used for cutting away anything with which the diver may become entangled

L. Ladder line, to lead the diver back to his ladder after having travelled over the space allowed by its length.

P Pricker, about 4 feet long, for probing or feeling in mud or soft ground.

S Shoes with lead soles weighing 12 lbs. each.

Fig 2. Front elevation of helmet, with the upper part screwed to the lower, shewing the centre circular lens, to unscrew when required.

Fig 3 Back elevation of ditto, shewing the nozzle for screwing the air pipe, and the escape valve for foul air

Fig 4 Section through the helmet, shewing the branches for the introduction of fresh air, the orifice for the escape of foul air, and the screw joint for connecting the upper and lower part

Figs 5 and 6 Plans shewing the alternate screw joint of connection.

Plate II

Fig 7 Side elevation of helmet

Fig 8 Plan of the lower part of helmet inverted, shewing the pads for the shoulders, and projecting screws.

Fig 9 Plan of the top of the escape-valve, with the orifice for inserting the pin and cover, shewn in figs 12 and 13

Fig 10 Side elevation of escape valve, shewing the circular apertures in the cover for the escape of the foul air

Fig 11 Section through the seat of escape valve, shewing the perforated cover screwed down

Figs 12 and 13 Shewing the section and plan of pin and cover of escape valve, with the spiral spring of brass wire tying on the cover

Fig 14 Thumb screw and plate for screwing up the lower part of the dress

Plate III

Figs 1 and 2 Front and side elevations of air pump.

a, a, a The three piston rods successively raised and depressed by the revolution of the cranks, *d, d d* on the horizontal axle, A B. The centre piston being raised to the top of its cylinder, shews the circular orifice, *b*, for the entrance of fresh air

a, a, a' Connecting rods

c, c, c The brass cylinders within the copper chamber, E

f The barrel for receiving the condensed air from the cylinders

g Nozzle at end of ditto, for screwing on the end of the air pipe the other end being fixed to the diver's helmet

h Suction pump for drawing up cold water from the sea by the flexible pipe, I, the water is discharged into the copper chamber E, by the metal pipe *k*, vertical motion is communicated to the pump rod, *m*, by the eccentric circle, *n*

l Fly wheel at end of axle

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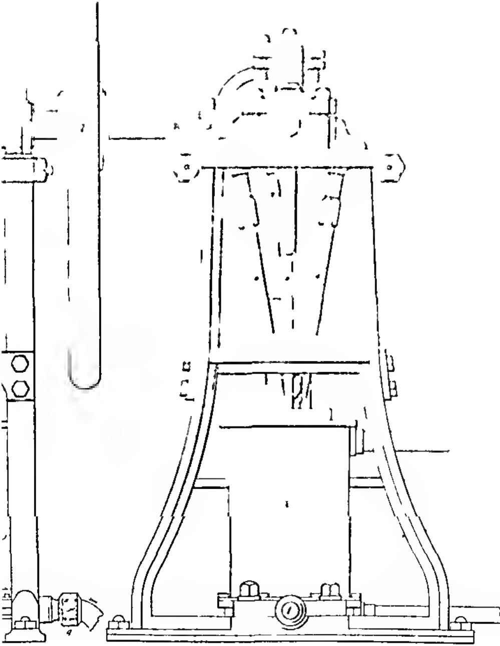
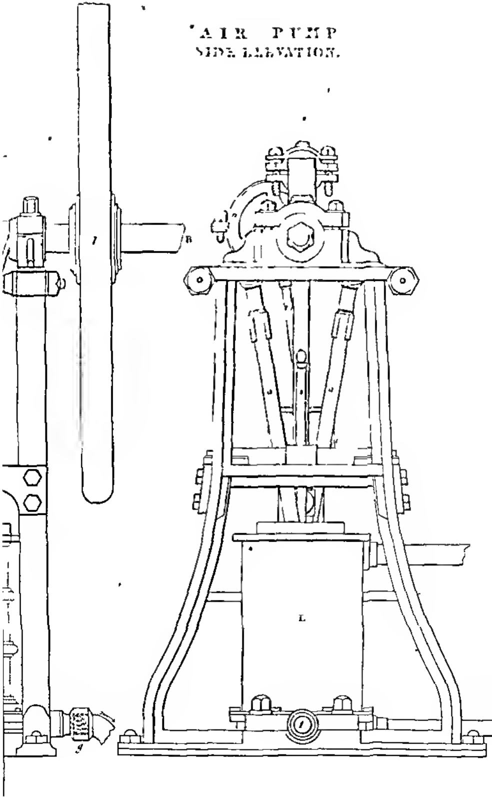
- *l* Fly wheel at end of axle



AIR PUMP

SIDE ELEVATION.



DETAILS OF AIR PUMP, CYLINDER & PISTON.

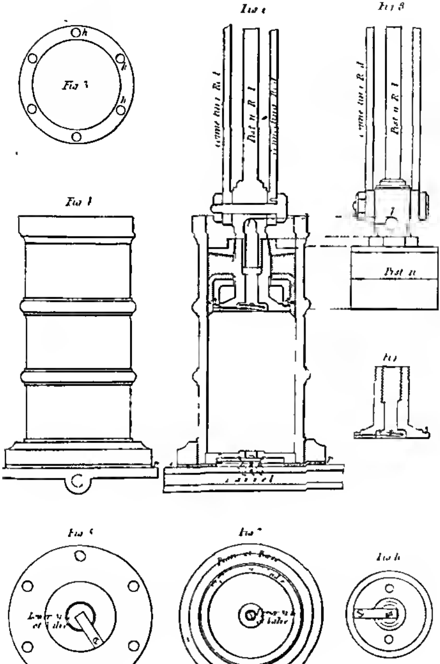


Plate IV.

Fig 3 Plan of top of cylinder The circular holes are for fixing a screw wrench to screw the cylinder to its bed

Fig 4 Side elevation of brass cylinder *o p* represents a leather washer, upon which the cylinder is screwed to prevent the escape of the condensed air

Fig 5 Plan of under side of cylinder, shewing the valve

Fig 6 Section through cylinder and part of barrel, with the piston drawn up shewing its valve, and the valve attached to the bottom of cylinder *h* Orifice and tube for the entrance of fresh air *h h, h* Orifices below for the passage of condensed air into the barrel This section represents the mode of screwing the piston rod and piston to each other, and of securing the pieces of leather of which the piston is formed *w w* Section of a circular wire spring which forces the under leather of the piston against the cylinder

Fig 7 Plan or horizontal section through the cylinder, shewing the upper side of lower valve

Fig 8 Side elevation of piston, and part of rods

Fig 9 Section through the metallic (brass) part of piston, with the pieces of leather, composing it, removed the inner screw receives the piston rod, the outer one is screwed into a brass cap or plate forming the top of the piston

Fig 10 Plan of the lower part of the piston, shewing the under side of valve

DRAINING may be generally considered thus: with reference to—

A Military purposes,
B Sanitary do
C Economic do

These may be further subdivided thus

A. *a* Draining an inundation lake, &c

" *b* Diverting the course of a river, stream, &c

" *c* Draining field works

" *d* Do the ditches and quarries of permanent works whilst in execution

" *e* Do fortifications as complete

" *f* Do unhealthy positions

B *a.* Draining unhealthy districts

" *b* Sewerage.

C *a* Territorial Reclaiming marshes, fens bogs, &c., for enlargement of territory on all scales—from that executed in Holland, for hundreds of square miles—or in our own colonies of Berbice and Demerara—down to the space to be recovered for large Government establishments, or for fortifications, or that of the private estate, or mere plot, to be rendered available for building ground.

" *b* Agricultural. Drying up the above descriptions of ground to afford the soil the advantages of warmth, of opportunities of exposure to contact with fertilizing matters (gaseous fluid and solid), and of killing the rank aquatic plants which are too powerful for co-existence with, or are otherwise obnoxious to those which it is desirable to cultivate

B and C are very generally connected with such embankments as will keep out the sea, and these embankments have, usually, such sluices [illegible] ternal waters at pleasure.

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DRAINING may be generally considered thus with reference to—

A Military purposes, } as the process of carrying off water as expeditiously as
D Sanitary do } possible, in opposition to arrangements for irrigation
C Economic do } and to dams, of which the object is to *retain* water and all control over its application —See 'Dam'

These may be further subdivided thus

A. *a* Draining an inundation, lake, &c
" *b* Diverting the course of a river, stream, &c.
" *c* Draining field works
" *d* Do the ditches and quarries of permanent works whilst in execution
" *e* Do fortifications, as complete
" *f* Do unhealthy positions

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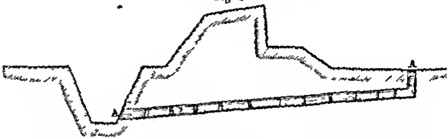
B and C are very generally connected with such embankments as will keep out the sea, and these embankments have, usually, such sluices as admit or exclude the external waters at pleasure.

Ae.—This can never be very extensive In small works, where the object is to keep the interior dry, the drains may consist of large fascines, A A (made of branches that would be considered rather too thick for ordinary purposes), le into the ground. Should this be insufficient in larger works, trenches should b cut, and filled in with middling sized gravel or small rubble —this is callec 'Rubble Draining' in both cases, leading from the lowest point of the space t be drained they can pass through the rampart into the ditch

Fig 5



The same can be applied to draining ditches, but then the latter mode is most likely to be in requisition

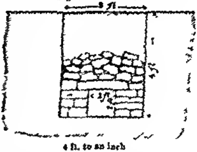
Af.—This is mentioned as only applicable on a small scale in the field; where unhealthiness springs from the dampness of the ground, it is more likely to be increased than reduced, in the first instance, by disturbing the *soil*; *especially* if there is much decomposed vegetable matter to be displaced The excessive sickliness at Corfu and Ceylon amongst the troops whilst new roads were being cut under this circumstance is decisive as to 'fact,' whatever may be the theories as to the cause, or even existence, of malaria.

If an extensive position, likely to be held for some years, is to be drained the troops not immediately wanted should be removed, as much as may be, during the execution of the work; the season should also be considered, and the inhabitants of the country should be employed as much as possible No detailed course can be prescribed as to the arrangement of the drains, but it is probable that the following sketch of what is done in some of the Irish bogs may be applicable in a general way

MEMORANDA* OF THE METHOD OF DRAINING LAND IN PART OF THE COUNTY TIPPERARY

"A general course for the water having first been found,† the levels of the ground are then taken, in order to find the best position for the main drains, for which excavations averaging 4 feet in depth and 3 feet in width are made: these excavations are then built in with dry masonry so as to leave a water-course 1 foot high and wide, covered over with rough flagging or other stone, they are then filled in further with loose stones and covered with earth these drains are sometimes 6 feet below the sur-

Fig 6.—Main drain



4 ft. to an inch

* By Capt J Freeth R.E

† Where it is not intended to change the water-shed this 'general course' will be often already decided by the old natural *water-courses* which may be in most instances much improved by cleaning and deepening in places, so as to *approximate* to the line A B in figs 1 2 But if it be desired to alter the water shed,—as for instance from a lake on one side to a river on the other —then a new channel must be provided as shewn in the paragraph to which figs 1 2 refer.—R. J N

face of the ground, and, where there is much water, the dimensions are increased to 1′ 6″ × 1′ 4″.

"For the smaller drains, excavations are made 2 feet 6 inches to 3 feet deep, and 10 inches to 1 foot wide; at the bottom of them stones are placed with the edges leaning against each other, so as to form an arched way for the water to run through, and they are filled in, to within about 1 foot from the surface, with loose stones, broken to about 3 inches cube.

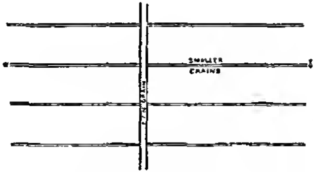
Fig 7.—Smaller drain.

4 ft. to an inch.

"These drains are placed in ordinary ground about 18 feet apart, but in very wet ground not more than 15 feet, sufficient fall being given to prevent the water from lodging in them: they are led into the main drains as shewn below.

Fig. 8.—Section through *a b*, fig 9.

Fig 9.



Scale 50 feet to an inch

"The expense and mode of operation will of course vary according to the description of country, the system shewn above being adopted in ground where there is a supply of stone raised in the excavations which is nearly sufficient for filling in the drains." R. J. N

E.

ELECTRICITY—as in various degrees called into existence on any change in the mechanical or chemical construction of bodies and the object of all electric apparatus (other than those for scientific investigation) is to *obtain control* over its direction when developed by natural causes, or over its action when produced artificially

As far as military purposes are at present concerned we have four principal subjects of application for what practical knowledge is available on this head.

1 The Lightning Conductor
2 The Electrotype
3 The Explosion of Mines
4 The Electric Telegraph, as associated with railroads considered as military communications

In No 1, the object is to permit a free neutralization of the electric forces and thus as it were, to afford a ready outlet to a violent agency that may do mischief to an indefinite amount, if not provided with such means of escape—in short, "to make a bridge of gold for a flying enemy," though it will be shewn shortly that gold is no longer considered the best material for that purpose

In Nos 3 and 4 the object is to apply to the work intended for it this same power when created and accumulated to any desired extent, by apparatus for effecting the changes before mentioned in either the mechanical or chemical constitution of certain bodies.—See 'TELEGRAPH' and 'VOLTAIC ELECTRICITY'

LIGHTNING CONDUCTORS.

The following notices are intended to embody such principles as are involved in arrangements for lightning conductors. The practical parts have been abridged from Sir W Snow Harris's different works especially that on Thunder storms, though, respecting any difference there may be between the more theoretical portions of the subjoined and his, it is to be observed that in arguing on the general development of electricity, that distinguished author's *reasoning is built on the Leyden hypothesis* of opposed surfaces

The distinction between 'Conductors' and 'Non Conductors' is arbitrary, and the line of conduction in all bodies may be considered to lie along the polarized molecules composing that line—whether we refer to metals as so called 'Conductors,' or to the air as an assumed '*Non Conductor*' in both the electric action passes from atom to atom along the course taken, though with far greater rapidity in the one case than in the other In this view of the atmospheric particles forming lines *and (thence as connected laterally in mass) spaces of conduction it is considered that* electricity is being perpetually evolved from the earth (as from a huge electric machine) by the incessant changes in the mechanical as well as chemical condition of its constituents, such changes for instance as those accompanying variations of temperature produced by the enormous extent of evaporation* from the land and *fresh water, as well as from the ocean,*†—*by the absorption* and *re irradiation of* solar heat, by the escape of central heat or by the decomposition and recomposition perpetually in progress over the face of the earth of all descriptions from slow

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* *It is right to observe* that this direct evolution of electric action by evaporation is in some degree a contested point

† The evaporation of sea water produces a greater degree of electrical excitement than that of fresh water —Kane's Elements of Chemistry' p 203

by a change of temperature which determines the existence of electric 'matter' in a form of palpable activity; and when these charged masses approach each other, either by electric attraction, or by the motion of air currents or other causes—then the restitution of the integral and original state of the electricity question takes place; the action of which, when of a destructive character, appears and terminates violently, along and at the end of the chain of intermediate polarized atoms of air, &c., in the forms of sheet lightning, forked lightning, or as the fire ball or 'thonderbolt.' When of a harmless description, it will be as the 'glow discharge'* (*to* a point)—as the 'brush discharge' (*from* a point), or as the 'summer lightning,' which confines its activity within the precincts of the cloud,—these two groups comprising all the known varieties of lightning

Although the greater conducting power of metals is thus considered as only a more intense and rapid form of induction,—and relative as the expressions 'conductor' and 'non-conductor' are,—yet the difference of those powers in certain bodies is enormous; that of iron, for instance, being estimated at 400 000,000 times greater than that of water.

The following Table gives in an approximate way the order of precedence in conductive power.

TABLE I†

	Conductors		Non Conductors or Insulators
Most perfect.	All known metals	Less perfect	Ice at 0° of Fahrenheit.
	Well burned charcoal		Dried vegetable substances
	Plumbago		*Dried animal substances, generally*
	Burning gaseous matter, as flame		Parchment, leather, feathers
	Smoke		Baked wood
	Concentrated acids		Oils and fatty substances
Less perfect	Dilute acids		Silk.
	Saline fluids	Most perfect	Fur and hair
	Living animals		Dry gases, including air
	Living vegetables		Pure steam of high elasticity
	Wood, in its ordinary state.		Glass and all vitrefactions
	Snow, and ice from 32° to 0°.		Diamond and transparent gems
	Water		Talc
Imperfect	Aqueous vapour		Amber
	Common earth and stone		All resins and resinous bodies
	Dry chalk and lime		Brimstone.
	Marble and porcelain		Shell lac
	Paper		
	Alkaline matter		

The ratios of heat evolved, and of those of conducting power, are shewn as follows

TABLE II ‡

	Heat evolved	Conducting power
Silver . . .	6	120
Copper . . .	6	120
Gold	9	80
Zinc	18	40
Platinum	30	21
Iron	30	24
Tin	36	20
Lead . .	72	12

* 'Comazants'—'St Elmo's fires' &c † From Harris on Thunder storms

‡ As given in Kane's 'Elements of Chemistry'

edges of the plate, it is necessary to coat those parts with varnish or grease which prevents the deposit taking place

The form of Daniell's battery may be modified when it is more convenient to place the object in a horizontal position by throwing a porous diaphragm horizontally across a flat box, instead of using the vertical porous tube, or in various other ways which will occur to every operator in the course of his work The principle, however, common to all this class of apparatus, which has been called *the single cell*, is, that the metal is precipitated at the negative pole of a simple battery, but it will be found that in whatever way a metallic substance can be rendered negative, so that hydrogen shall be evolved at it, there will the metal be precipitated.*

We may therefore use any battery which is sufficient to decompose acidulated water between platinum poles, and it will be found that metal will be deposited at the negative Here is presented an immense advantage. We can separate the battery from the decomposing *trough*, and instead of replenishing the solution by adding crystals or by other mechanical means, we can use the affinity of metals for oxygen to effect their decomposition, and for the positive platinum pole substitute a plate of the metal we wish to precipitate, i e the same as in solution Then, as the metal is deposited from the solution, the oxygen and acid being set free, will dissolve the positive plate, and maintain the solution of the same strength (See fig 2, Plate I)

The form of the precipitating trough must depend on the size and form of the object to be copied, the solution,—on the metal to be thrown down The battery may vary also always remembering that quantity is more concerned in electrotype operations than intensity The intensity we can vary by increasing the series, by using different exciting liquids in the battery, or diminishing the distance between the plates in the trough; the quantity, by changing the relative size of the plates in the battery, by joining the zincs of several pairs, or by increasing the strength of the battery liquid. When the operations are to be of long duration it is important to adopt the arrangement which will give the most economical amount of power. This may also be obtained in most cases from a single pair, always having relation to the surface intended to receive the deposit; besides which, a certain degree of density or 'tension' of electricity exterior to the battery would appear necessary; but it may be interfered with by the resistance of the solution, because solutions like metals, are subject to variety in their conducting powers, and the passage of the current may be resisted by various causes; among others, by the distance through which it has to pass, the nature, the strength, and the temperature of the solution, by altering the one or the other of which, the resistance may therefore be diminished. It is also to be remarked in reference to the solution, that the presence of metallic particles in the solution, such as sulphate of iron added to a weak solution of sulphate of copper, for example, will facilitate the deposit of copper

LAWS

It is desirable to explain succinctly the laws which regulate the deposit of metals from their solution a due knowledge and recollection of which will guide the operator in the use of them, as a knowledge of the principles on which batteries and other apparatus depend will guide him in using the one or the other. Mr Smee has reduced them to three.

* It may here be remarked, that for convenience throughout this article the composition of the salts is spoken of as formerly understood not according to the newer theory by which sulphate of copper for example consists of sulphuric acid + oxygen + copper instead of sulphuric acid + oxide of copper—the practical results being for the present purpose the same

1st. The metals are thrown down *as a black powder* when the current of electricit is sufficiently strong, in reference to the strength of the solution, to cause hydroge to be violently evolved from the negative plate of the decomposing cell.

2nd They are thrown down *in a crystalline* state when there is no evolution o hydrogen, and no tendency to it

3rd They are thrown down in a *reguline* state (*i e* having the properties o ductility and malleability) when hydrogen is on the point of being evolved, and when the minutest quantity of gas begins to appear at the negative plate

Here then we require the combined influences of quantity and intensity, and are guided to the best arrangements We require sufficient strength in the battery to act upon and dissolve the replenishing plate. Now if we pass a large quantity of electricity through a weak solution, we shall have the metal deposited in the utmost state of brittleness The reverse will produce large crystals of the utmost hardness The principal powers of change we possess are, the size of the battery, the strength of the solution, the arrangement of poles in the decomposing cell, and the temperature of the solution

We can obtain the black powder

1st *From any given solution*, by increasing the intensity and quantity of the battery, by a series, by altering the size of the negative poles, and by increasing the temperature

2nd *With any size of the negative plate*, by increasing the intensity and quantity of the battery, by increasing the positive electrode, by weakening the solution, adding to its acid and approximating the poles

3rd *With any given battery* sufficient to decompose water, by diminishing the size of the negative pole and increasing the positive, by approximating the poles, or weakening the solution with dilute acid

We can obtain the metal in a crystalline state

1st *With any given solution*, by increasing the quantity and diminishing the intensity of the electricity, by increasing the positive and diminishing the negative pole, and approximating them

2nd *With any given negative plate*, by diminishing the intensity of the battery, enlarging its size, saturating the solution with the salt, enlarging the positive plate, and approximating it to the negative.

3rd. *With any given battery*, by strengthening the solution, diminishing the negative electrode, increasing the positive, and approximating them

Our great object, however, in electrotype is to obtain metal in the reguline state, *i e* to obtain the exact point of evolution of the hydrogen, and it is by no means easy to lay down any general rule If it be too abundant, we may increase the *negative pole or diminish the positive But if we wish to have the poles of the* same size, which is often indispensable, we may reduce the size of the battery plates, or weaken its exciting acid. Variation in the distances between the poles will also regulate the evolution of hydrogen sufficiently in some instances, or supposing all these impracticable or inconvenient, we may keep the evolution under tolerable control, merely by regulating the strength of the metallic solution, and the quantity of acid it contains The following experiment exhibited these laws in a very simple [illegible]

[illegible]

[illegible]

quantity of water, and a fourth diluted with twice its quantity of water A slip of the same size formed the dissolving plate, at a distance of half an [illegible] The above, connected with Smee's battery, in a solution of water 30 1 [illegible]

quantity At the bottom, the quantity deposited was small and crystalline Between the saturated and half saturated solutions it was most abundant and elastic The next above was spongy, and at the top was a dark brown powder

With the same battery arranged for intensity, all other circumstances the same, the effects to the eye were very similar, but the deposit was more copious

The deposit from the semi saturated solution in both cases was the best, *i e* the most reguline but it became more granular as the intensity increased.

It may be useful to describe the mode of arranging the same battery for quantity and for intensity In the first case, the zincs are connected with each other, and the plates of platinized silver with each other, as in fig 3 Plate I In the other, the zinc of the first pair is connected with the platinized silver of the second, as in fig 4, Plate I These modes of increasing quantity and intensity may be extended to the connection of any number of pairs, but if the experiment be of long duration and arranged for intensity, it is peculiarly important that the zinc plates should be all of equal purity, for if the exciting liquid of any cell become saturated by a greater amount of local action on the zinc its exciting power will cease, and that cell will become in fact a decomposing trough, depositing zinc on the negative plate This peculiarly recommends the single pair arrangement for the purpose of electrotype

APPLICATIONS

The principal use which the Engineer Department has hitherto made of electrotype is in the duplication of engraved copper plates on the Irish Survey, to which purpose, after numerous preliminary experiments, it was first practically applied in 1840, for inserting contours in the county of Donegal.

It affords a mode of multiplying maps *ad libitum*, and preserving the original plate, by providing duplicates from which impressions may be taken, while the original plate remains wholly uninjured. It also affords a convenient mode of representing various kinds of information on the same outline or ground work, as for example, in the illustrative plates of the Census of Ireland in 1842, the same outline map is used to represent on successive plates the density of population the extent of education, and other subjects, merely by making as many electrotype copies of the first plate in its outline state as are required and completing each copy with its peculiar information. A matrix is then taken from each plate, the matrices joined, and the duplicate produced in a single plate, so that, in printing, an impression is taken from the whole number so joined with each passage of the plate through the press It also affords great facility for the *correction* of maps, and insertion of new matter, by substituting for the ordinary mode of correction (viz., erasing or scraping out the erroneous work, and hammering up a new surface from the back to receive the correction) the more exact and less costly mode of merely scraping the erroneous work from a matrix, which yields therefore a blank copper in that place The smallest spot in the most crowded work, as a house in the midst of a town, for instance, can be corrected by this means, which by the ordinary mode would always require the sacrifice of a greater or less quantity of correct work around it In this way a plate containing the city of Dublin has been corrected for less than one fifth the expense of re-engraving

The battery which has been found most suitable is that of Smee Its simplicity of construction, requiring but a single cell, was very important in plates of the size required, where porous cells would have been very expensive, if practicable. The cheapness of the exciting acid (sulphuric) and the greater ease of cleaning the single zinc element than the numerous zincs where porous cells are used, with the consideration that quantity was the great desideratum, at once recommended it, and after

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metal can be deposited opon it, although the dissolving plate will continue to be acted on When the plates are in a vertical positioo, facing and parallel to each other, the deposit becomes unequal, *i e* upon the lower portion it is much thicker than upon the upper; it is generally studded with globular concretions of the metal, and lines or grooves extending upwards, while the upper part remains thin, and when the solution comes to a certain stage of saturation, or rather of exhaustion, it is covered with the sandy deposit, aod at last a dark brown powder

The same inconvenience is felt in the horizontal position, and from the same cause When the receiving plate is under the dissolving plate, the solution in contact with its surface rapidly becomes of different density in different parts; and as some portions of it are thus more favourable for deposition, a current is established and maintained if the solution is oot disturbed Under certain circumstances, the metal grows vertically in needle-shaped points, to the height of half an inch or more, nearly completing the circuit by contact with the other plate Under ordinary circumstances, the back of the plate becomes studded with the minute globes before described, which from their lateral growth meet, but have no cohesion, and are in their turn covered with others Under other circumstances, the plate becomes covered with circular cavities, which become smaller as the metal is precipitated on their upper edge, and at length are covered over, enclosing every impurity that may have fallen. It is obvious that metal so formed must be spongy and useless

When the dissolving plate is downwards, the dense portions of the solution will subside to the lowest part of the cell, or remain in the hollows of the plate, upon which it will crystallize, while the lighter, from its tendency to rise, causes a current to pass along the surface of the receiving plate, in the direction of its most elevated part, the course of which is marked by the dark colour of the deposit If it meet with obstructions or hollows oo the surface of the plate, it is retained, till reduced to that degree of density at which the granular or sandy deposit takes place, aod if the solution should be disturbed before it has been observed, the loose grains are covered with the next quantity deposited, forming a porous or spongy part in the new plate, which if near the surface, would render it unfit for engraving

These evils may in some degree be diminished by slow deposit, the solution having greater time to mix But this is insufficient to obtain the great desideratum of maintaining uniform density in the solution, and removing from contact with the receiving plate that portion from which a part of the metal has been precipitated before it is reduced to that state at which the brown or granular deposit takes place, that is, before the quantity of metallic particles in the solution is so reduced as oot to be sufficient to engage all the current, and allow the water of the solution to be acted on

The remedy for these evils is to be found in agitating the solution, and the result will be more evident with a battery of sufficient power to decompose water violently In such a battery if the plate to receive the deposit be suddenly plunged vertically, so as to produce as little movement as possible in the fluid, it will instantly evolve hydrogen, become coated with the dark brown deposit, and gradually covered with granular concretions, but if by some mechanical arrangement the solution be kept in constant agitation, or the plate kept in motion, the deposit will go down evenly, *rapidly*, and *of good colour* and consistence After a small quantity has been deposited, the agitatioo may be less frequent, but if the plate be removed for a few minutes, and again immersed, the brown powder will again be thrown down, unless the agitation be resumed.

Among other batteries, these experiments were made with one of Daniell's constant batteries in a series of ten cells, each exposing a surface of 36 square inches of posi-

tive metal; the surface of the receiving and dissolving plate being at first each 5 square inches, and subsequently the receiving plate reduced to 2 square inches, the dissolving plate remaining the same The solution operated on was sulphate of copper acidulated, about one pint in a glass jar, the temperature of which, it may be remarked, was raised 45° in 30 minutes by the operation The quantity deposited in 10 minutes was about the thickness of strong writing paper, perfectly solid, reguline, and easily removed from the plate

From the above it would appear that with the same battery, the same solution, at various degrees of temperature, the receiving and depositing plates of equal or of different size, either of the characteristic deposits defined by Mr Smee may be obtained, *provided the solution be kept in agitation, the receiving plate first immersed, and the dissolving plate inserted gradually*

This branch of the subject has been dwelt on at somewhat greater length than would otherwise be necessary, because it occurs chiefly in large operations, and such are most likely to be used in the Engineer Department, whether as in the instances which have led to the present article, in the creation of duplicate copper plates of considerable dimensions, or in the coating of metallic or other substances used in constructions, with a view to their preservation To many such purposes there can be no doubt but electro-metallurgy will be applied The science at present is wholly in its infancy, and in this notice little more has been attempted than to lay down a few general principles which will be found essential in all cases

It has been proposed to perform the corroding process of etching by connecting the plate to be acted on with the positive pole of a battery, making it, in fact, a dissolving plate; from which various advantages may result in certain cases, as in diamond ruling, where it is desired to obtain a very smooth line, which engravers feel it difficult to obtain by the ordinary means because the local action constantly produces irregularity, from the adhesion of bells of hydrogen to the sides of the line This is wholly avoided in the voltaic operation, as the action takes place by direct combination of oxygen with the copper but without the evolution of hydrogen, producing a line of equal depth, and giving to copper the exactness of steel

When it is desired to strengthen the original work on a plate, i e to make the lines on the duplicate plate stronger than they were on the original, it may sometimes be accomplished by charging the old work with ink, and throwing down a thin deposit of copper, which will not settle on the ink, from its oily nature then removing the ink in the ordinary way, when it is obvious the blank portions of the plate are raised, or conversely, the engraved work is deeper; and accordingly when the plate is again submitted to the process, the result will be a stronger work on the duplicate plate To avoid all risk of adhesion and consequent injury to the original plate, it is desirable to take a facsimile duplicate in the first instance, and work upon that duplicate, leaving the original quite safe

A new species of engraving has also resulted from it, and been practised in the Ordnance Survey Office, viz., ruling a plate all over carefully and taking duplicates from it, having first scraped from the matrix, after the manner of mezzotint, all the parts where lights are required This is very applicable to engravings of towns and probably to hills; to every thing in fact, where an uniform ground is desirable It is needless to detail the numerous uses of this valuable art which are daily occurring

It has also been used for copying scales and divided instruments, which will probably become a source of great economy,—a scale which costs several shillings being produced for a few pence.

Some very perfect casts of fossils were very early made by Mr William Dalgleish, and while the Geological Survey was under the Ordnance a very elegant application of this power was effected by Captain James, R E, viz, preserving the rare and unique specimens in the country where they are found, and depositing copies made by this process in other museums Several very beautiful specimens were prepared under his direction for this purpose

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Description of Plate I.

Fig 1 Original single cell apparatus
2 Horizontal decomposing trough detached.
3 Two pairs of plates arranged for quantity
4 Two pairs of plates arranged for intensity.
5. Pair of battery plates in the electrotype apparatus at the Ordnance Survey Office, Dublin

Details

A. Wooden frame for supporting the plates, which rest upon brackets fixed to the inside of the battery cell, at a sufficient distance from the bottom to allow space for the sulphate of zinc to sink below the plates

B B Plates of silver platinized.

C Plate of zinc

b b Conductors from the silver plates (negative)

c Conductor from the zinc plate (positive).

d Connecting piece for joining the negative conductors, through which the positive conductor (c) passes

e e Conducting wires leading to the decomposing trough

f f f Copper bar, with prepared canvas straps for suspending the zinc plate between the silver plates, and keeping them at the proper distance asunder, which is withdrawn when the zinc plate is required to be removed for the purpose of cleaning, and to which is affixed an eye (*g*) for raising the whole frame and plates, when they are to be inserted into the battery cell.

h Screw, with a similar screw on the opposite side of the frame, for the purpose of pressing the silver plates towards each other as the zinc grows thin

Description of Plate II.

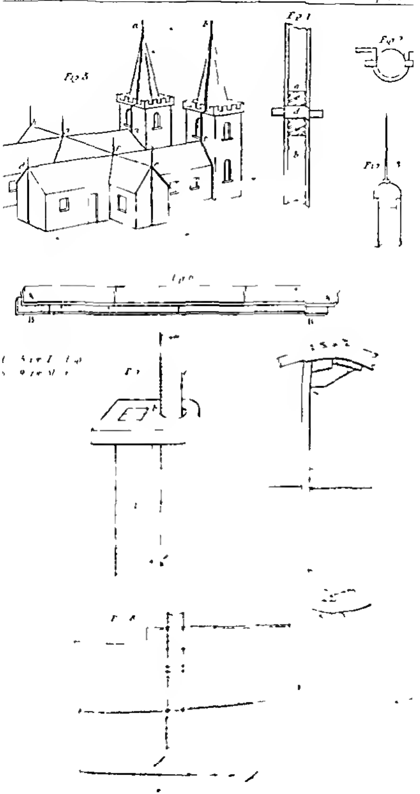
A The battery cell, extending downwards 2 feet under the floor, and terminating in a point, in which a stop-cock is fixed, to draw off the saturated solution of sulphate of zinc which is formed there The bottom is reached by a trap-door and steps.

B. The decomposing trough, resting on a keel, which, for the purpose of agitating the solution, enables a rocking motion to be given to the trough, by means of a coupling shaft (*a*) connected with the truck (*b*) on which the trough is moved to any part of the room, for cleaning or changing the plate

[illegible]

receiving plate (*d*), the latter being placed on a board, with small feet or wedges to keep it at the proper distance from, and parallel to, the positive plate

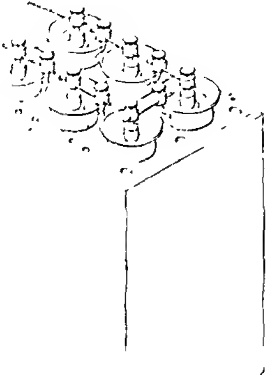
D A water tight box containing a solution of sulphuric acid in the proportion of



EXPLOSION OF MINES PL 8

Details of Professor Daniells Cylinder Battery

Fig 1



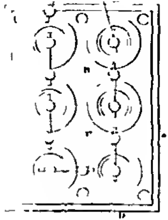


Fig 3

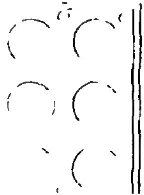
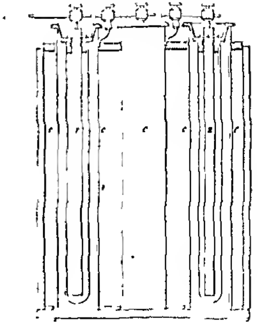


Fig 4



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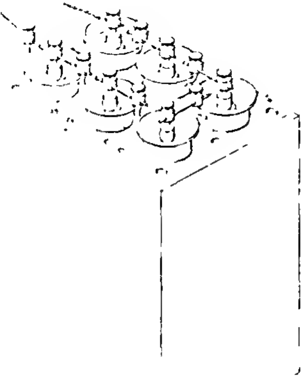


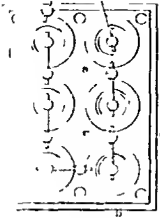


Fig 3

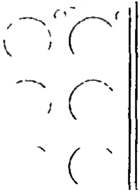
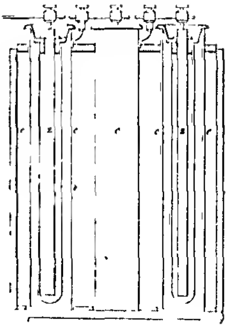
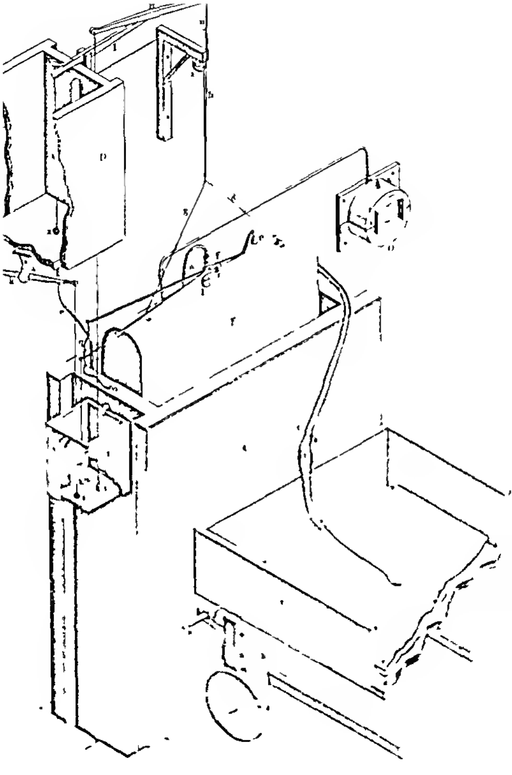


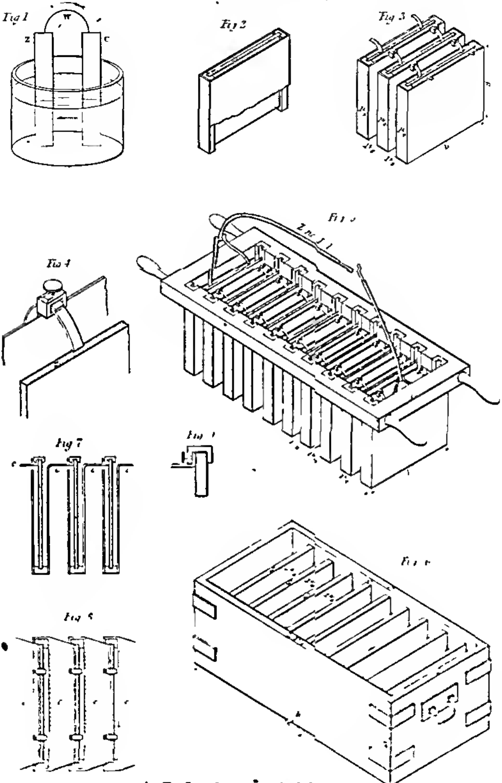
Fig 4





EXPLOSION OF MINES PL. 1

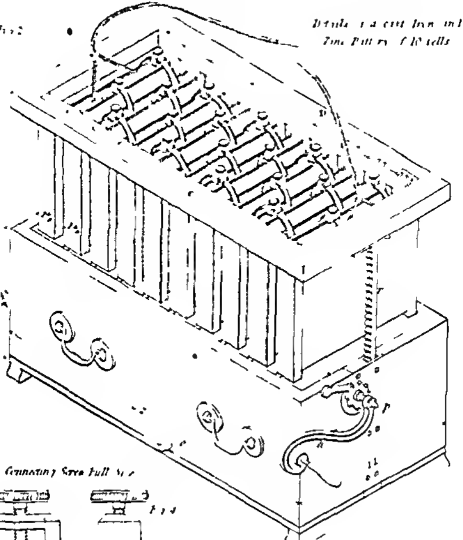
Details of a Voltaic Zinc & Copper Battery of 10 cells



EXPLOSION OF MINES PL 2

Fig 2

Details of a Cast Iron and Zinc Battery of 10 cells



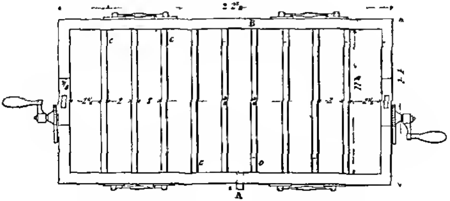
Connecting Screw Full Size

Fig 3 Front

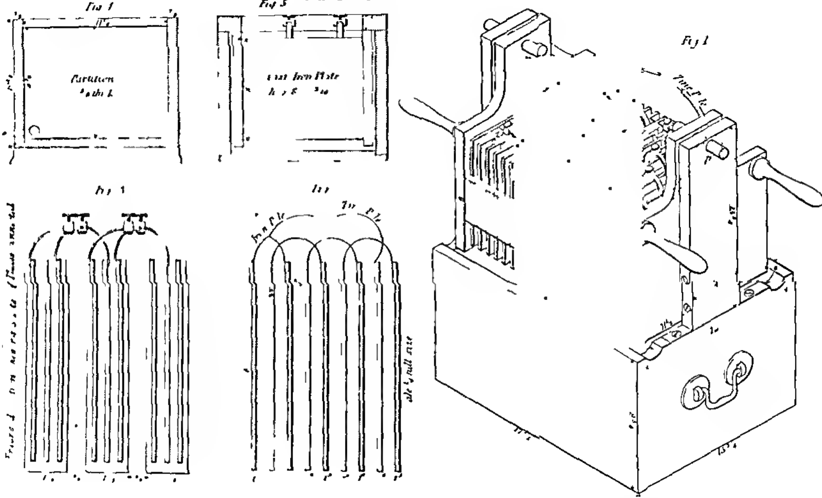
Fig 4 Side

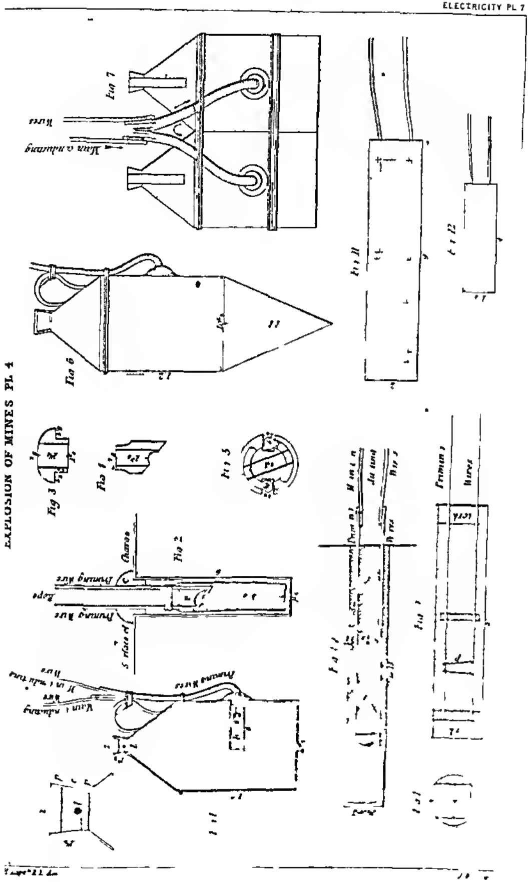
Elevation

Fig 1



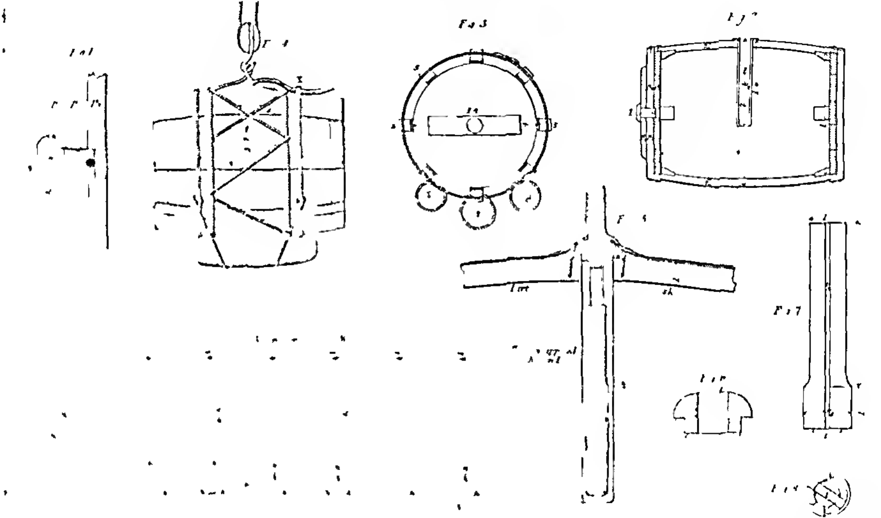
EXPLOSION OF MINES PL 3



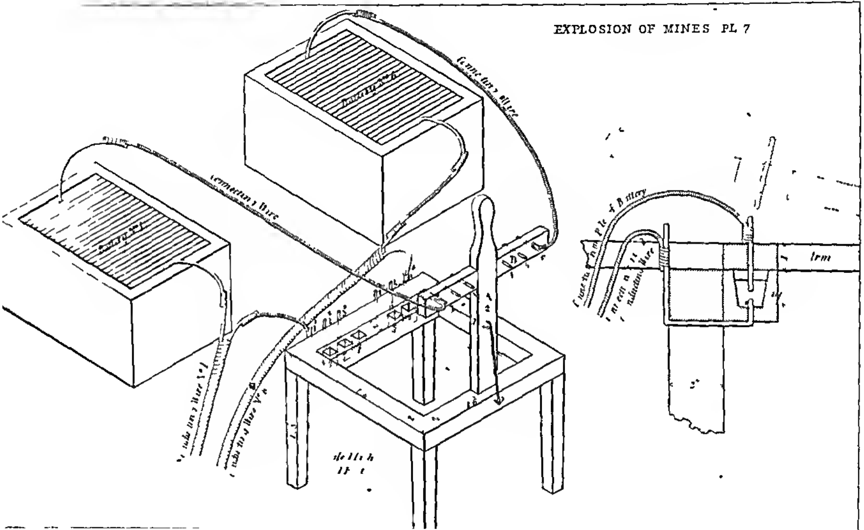


EXPLOSION OF MINES PL 4

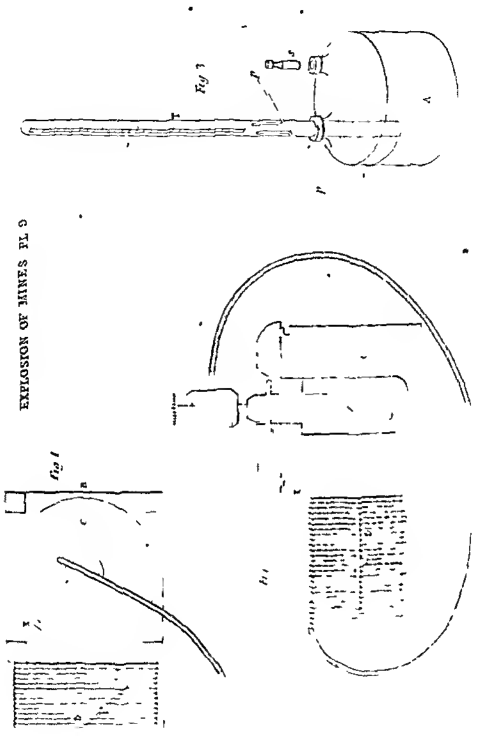
EXPLOSION OF MINES PL C



EXPLOSION OF MINES PL 7



EXPLOSION OF MINES PL 9



1 to 4 water, by which the battery cell (having been originally charged with solution of the requisite strength, 1 to 30) is constantly supplied with renewed acid, through a lead pipe (*e*) which extends downwards into the cell about 2 feet, and is turned horizontally so as to cause a circulating movement in the solution. The box is provided with a float (*f*) to indicate the height of the acid solution in it, and the quantity which has passed into the battery.

N. B. In this Plate the acid box is placed near the battery cell for the sake of bringing it within the margin lines. It is nearly close to the ceiling, in reality, so as to afford by its height a considerable force to the solution issuing from the pipe, that it may circulate freely around the battery plates.

For want of height in this Plate, it has also been necessary to omit a beam which passes along the side of the room nearly close to the ceiling, on which a small carriage and pulley travel, for the purpose of raising the plates and moving them to any part of the battery range.

E. A gasometer, or gas collector, formed of thin copper, suspended by the wires (*g*) and the cord (*h*) which passes over the pulleys (*i i i*), and terminates in a counterpoise (*k*), intended to balance in part the collector, which is placed immediately over the plates in the battery, and dips into the solution. It is furnished with a stop-cock (*l*), through which the gas passes by the flexible tube (*m*) and copper pipe (*n*) to a gas meter (*o*).

F G. Levers, the former (F) being attached to the plug of the stop-cock, having at one end a weight (*p*) and at the other a chain (*q*) fastened to the battery cell, the latter (G) turning in the same centre, and brought by a screw (*r*) at one end into contact with the under part of the former (F), and kept in contact with it by the pressing of the weight (*p*). To its other end a small block of wood (*s*) is attached, dipping into a waste box (*t*), and acting as a weight when the box (*t*) is empty, and as a float when the box is filled by overflow from the battery cell.

H I. Levers, drawn downwards by the weight of the collector, with which they are connected by the cord (*u*). The former (H) turns on a pivot at the end of the latter, having at its other end a cord carrying a weight (*v*) which acts in the same manner as *s*, the latter (I) carrying, as before mentioned, the lever (H) at one end, and having at the other end a spring (*w*) screwed to it, from which a wire, passing through the lever, descends to the valve (*x*) for the purpose of raising the valve suddenly, being first closed upon the lever until the adhesion of the valve to its seat is overcome, when the spring returns to its former position with a jerk, carrying up the valve, and opening the aperture at once to its greatest extent.

K. A lever fixed to the bottom of the box (D), having at one end a small hole through which the cord (*h*) passes until checked by a knob (*y*), when the other end of the lever rises and lifts a valve (*z*) in the bottom of the box (*t*).

Working of the Apparatus.

The operation proceeds in the following manner. The aperture of the stop-cock (*l*) must be so adjusted by the screw (*r*) as to allow the gas evolved from the plates of the battery to escape at the same rate as that at which it is generated, allowing a slight excess to resist the uncounterpoised portion of the weight of the collector or its tendency to sink down. Then, when the quantity evolved is greater than can pass through the aperture, the collector will ascend till the lever (F) is restrained by the chain (*q*), when the aperture will be enlarged till equivalent to the quantity evolved.

At or about the same time, a Miner Company of about 200 men of all classes was recruited from the Native Military Miners of Upper India. They were under very little discipline, with no training beyond their own traditional practice, and, when not in the field, were put under the Staff Officer of the station they might be at. The Officers of Engineers never saw anything of either the Pioneers or Miners, except when they met on field service, and there was, consequently, a good deal of mutual ignorance of each other's mode of proceeding, not favourable to the public service. These considerations led the Indian Government to decide on the commencement of the present system, and the Corps of Sappers and Miners was directed to be organized by Captain R. Tickell, (now Lieut.-General R. Tickell, C.B.,) the Officer in the Corps (then of the strength of 2 Battalions, or 40 Officers) who had the greatest experience in field duties. The old Company of Miners was taken as a nucleus; volunteers were admitted from the Corps of Pioneers, and fresh men were enlisted for this particular Service. They were formed into a regular Corps of 6 or 8 Companies, with a non-commissioned European Staff trained at Chatham, and young Officers of the Corps of Engineers attached to them. The duties and practice of the Corps were conducted on the same system as in the Royal Engineers, and a very efficient Corps of Sappers and Miners formed. This was soon followed by the abolition of the Corps of Pioneers, whose duties devolved upon the new Corps, which became a good deal dispersed about the country, and were employed on work heretofore performed by the Pioneers in times of peace. This has greatly interfered with the very efficient system of practical education commenced; but the Corps has been more and more drawn together again, and is, probably, benefiting by a more extended practice in their most essential branches of training. There still, however, exists the great defect of a want of mutual acquaintance between the Officers of the Corps (now 92 in number, or strength of 4 Battalions) and the men. It is the custom for young Officers, on first reaching India, to be posted to the Corps of Sappers and Miners, with which they do duty for one or two years: this, however, is not universal (a late Order places them for three months with a department at Calcutta, to learn the theory and practice of forming iron bridges and roofs). From the corps they are appointed Assistants in executive departments, in which they continue and rise, and hardly ever return to the Sappers, or see anything of them, or have any practical experience in field duties, except when in the field, when the Engineer Officers nearest at hand are called in, and in camp meet with a detachment of Sappers under their own Officers. They certainly meet with men well trained, accompanied by an efficient non-commissioned European Staff, tending greatly to expedite and simplify all field or siege operations, but it appears an evil, when such care was taken in the formation of the corps, that a batch of Officers were not attached to them, of which a portion should be annually relieved, so bringing the whole corps of Officers in contact with the men, under a practical course of military engineer duties, at least once in eight or ten years, instead of, as now, never after their first outset in the Service.

The general duties of the Corps are presided over by the Chief Engineer quartered in Fort William.* He has, however, little position or power beyond that of being, *ex officio*, a member of the Military Board, to which every Executive Department of the military service in India is subordinate. In the field, the Officers called on for service are nominated to be Principal Field Engineers, Field Engineers, or Assistant Field Engineers. When sufficiently numerous, they are brigaded, with a suitable Staff, but generally the duties are conducted by a Field Engineer, with one or two Assistants. These Officers report direct to the Chief Engineer, but for supplies of tools or stores for working parties beyond what the Sappers may have, they apply to

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after a certain service commensurate with the advantages he has received But still however, what is chiefly required is to place the officers or men at an early period in an active and responsible position, when they will become sufficient for our Service after going through the probationary studies they generally receive, but the nature of Colonial and detached service does not always render this possible and hence the necessity of a re union at Chatham, or any other head quarter station where some Officer of high authority might be the controlling power, similar to the existing Artillery arrangements at Woolwich

SECTION II.

THE ENGINEERS OF THE HONOURABLE EAST INDIA COMPANY'S SERVICE *

The Corps of Bengal Engineers originated in the appropriation of Officers from other branches of this Service to the performance of Engineer duties, with such supplies of tools and stores as could be spared from the Artillery Park In the course of time, Cadets for this Service of the East India Company, in the Ordnance Departments, were received for education at the Royal Military Academy, Woolwich, whilst others were deemed eligible, educated at private establishments, but subjected to examination by the Examining Officers of the Royal Military Academy These proceeded to India for the Artillery or Engineer Services generally, and thence the seniors were allowed the option of filling up any existing vacancies in the battalion of Officers, thus forming the Engineer Corps, after having done duty with the Artillery for from 6 to 12 months Sometimes a further examination took place and the selection was made by Government, when the Cadets were finally posted. This continued till 1809, when the present Addiscombe Establishment was formed after which no nominations for training elsewhere were made From Addiscombe, at first the Cadets went to India as before, for the Artillery or Engineers; but at the end of a year, the first step in improvement was made in making the selection for the different branches in England, and retaining those appropriated to the Engineers for further instruction in the special duties they would be called on to perform this was followed by the East India Cadets being admitted to all the benefits of the course of practical instruction at Chatham and such continues to the present time In India the duties expected to be performed by the Engineer Corps of Officers (for a long time there were no men attached to them) are multifarious In times of peace, they are expected to be competent in every branch of civil engineering, not only theoretically but practically, having often to instruct the artisans in the best mode of performing their work They are supposed to be able accountants, having often intricate details of accounts to manage, they being always executive officers in charge of all *the details of expenditure* *They are further supposed* to be capable of surveying in any requisite degree that the public service may demand; and under the name of Garrison or Executive Engineers of Districts are in charge of all the fortifications and public works generally, including roads bridges, and irrigation canals, though there are necessarily exceptions, from the relative paucity of officers, compared with the work to be done In the field, the duties, on the first establishment of the Corps, were performed in the best manner that circumstances permitted by one or two

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* By Lieut.-Colonel Colvin Bengal Engineers Given by this Officer as referring exclusively to the Bengal *Presidency*; but the organization of the Madras and Bombay Engineers is similar —*Ed*

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projects are made, the Officer who frames and signs them, whatever be his rank, shares with the Commanding Engineer the credit or the responsibility, though the latter approves of them by placing his signature thereto

3. Commanding Engineers do not correspond direct with the Minister of War All the documents and plans which relate to their Service are first of all addressed to the District Director of Fortifications, who resides at the head quarters of the district This Officer lays them before the Minister, with his own notes and remarks, and the decision of the Minister is made known, through the same channel, to the Commanding Engineers

4 The Directors of Fortifications have the following especial duties 1st To give their advice and experience to Commanding Engineers 2ndly, To obviate on their own proper authority many of the difficulties which may occur in the execution of the works, and for which the opinion of the Minister would be too slow, or not sufficiently detailed 3rdly To inform the Minister precisely of everything which bears a relation to the defence of the frontier. 4thly To act as an intermediate authority between the Minister and the Commanding Engineers

5 It follows from the evident importance of the situation of Director of Fortifications, that generally all documents of work proposed in the office of the Commanding Engineer should be made in triplicate—one for the Station, one for the District, and one for the Minister

6 The Director of Fortifications should pay every year at least two visits to the stations in his district one in the spring, to set the works ordered a going, and another in the autumn, to witness the execution of them, to check and sign the measurements, and discuss with the Commanding Engineer estimates to be brought forward in the ensuing year. When the works are but few in number or of no great importance, the Directors pay but one yearly visit, in the autumn

DUTIES OF THE CORPS DU GÉNIE IN TIME OF WAR.

1 When in the field, l'État-Major du Génie is generally composed of a General Officer, who takes the title of 'Commanding Engineer of the Army,' a General Officer, Chief of the Staff; a Superior Officer, Director of the Park, in fact, of a greater or less number of Superior and Inferior Officers, as well as Gardes du Genie, according to the wants of the Service

2 To every Division of Infantry is attached a Commanding Engineer, of the rank of at least First Captain

3 If an army be formed to act separately, a Commanding Engineer is attached to it (who may only be a 'Superior Officer'), or Chief of the Staff, and a Chief of the Park (if there be one), who may be only Captain

4 The Engineers attached to the army are employed on works of permanent fortification, on those for the attack or defence of a place, and on those of such reconnoissances as are entailed by such works

5 They may also be required to construct the field works which the Generals of the Army or of the Divisions may think fit to establish, such as attacks and approaches, redoubts, small forts blockhouses, têtes de pont intrenched lines and camps, dykes, &c , also works on the march, such as opening communications, the construction or demolition of roads, bridges &c., &c

6 General Officers and Officers of all ranks in the Engineers, who are not attached to a company, form part of the Staff of the Army, of the Corps d'Armée, or of the Division to which they are attached

7 Every Commanding Engineer receives direct, or through the Chief of the Staff, the orders of the General Officer to whom he is attached, he informs this General of the orders given to him by the General Officers of his own Corps

8 When it is necessary to establish permanent garrisons in places, or military posts, either conquered or formed by the army, the Engineer Service takes in these places or posts the same duties as at home stations

9 Officers of Engineers are forbidden to communicate to any other person, except to the General of the *Army, or to the General Officer to whom they are* attached, or his Chief of the Staff, the state of the supplies, &c, or the plans of places, or of works executed or in execution.

10 The composition of all armies is that of Divisions This principle of several divisions under one Commander composes either an army, a wing, or a centre of an army, or a reserve. The division is generally formed of two or three brigades, either of infantry or of cavalry; it includes troops of different services in the proper proportion

TROUPES DU GÉNIE *

Les troupes du génie sont *composées de sapeurs et de mineurs Elles ont géné*ralement pour destination d exécuter toutes les constructions nécessaires pendant la guerre; de retablir les fortifications de toute nature, tant sur les postes isolés, que sur les principaux débouchés et dans l'intérieur du pays; de detruire tous les ouvrages de cette nature appartenant à l'ennemi, lorsque cette destruction n'a pu s'effectuer entièrement par le feu de l'artillerie; de reparer ou de construire les ponts fixes, les digues et les routes ou autres moyens de communication, de les détruire s'ils nous sont nuisibles Les troupes du génie doivent donc aider à détruire tous les obstacles naturels ou artificiels qui servent à la défense, ou à les construire s ils deviennent nécessaires. Les soldats du génie sont par conséquent plutôt des ouvriers que des combattants, et ils ne portent des armes que pour leur défense personnelle; car pendant leurs travaux, ils sont protégés par d autres troupes Cependant, ce serait commettre une grande injustice, que de ne pas placer cette classe si estimable de soldats au même rang que les grenadiers, les cuirassiers et les canonniers, car il ne suffit pas que les troupes du génie executent avec adresse et célérite les travaux qui leur sont ordonnés, mais elles sont presque toujours obligées de le faire dans des circonstances difficiles, et même sous le feu de l'ennemi, ce qui exige un grand sang froid et une intrépidité égale à celle qu'on peut désirer des autres soldats

ENGINEER, CIVIL

SECTION I.

ENGINEER, CIVIL, GENERALLY †

This profession may almost be said to have originated in England within the last century Before the middle of the last century, whenever the prospect of great profit induced individuals or bodies corporate to undertake extensive systems of drainage, and for this purpose to call for the assistance of an engineer, recourse was generally had to those great masters of hydraulic engineering, the Dutch True it is that some solitary exceptions have occasionally been found, men who, like Sir Hugh Myddleton, combined a speculative turn of mind with some mechanical knowledge, and to these two qualities added an untiring energy of purpose leading them to persevere in any undertaking, even under the most discouraging circumstances But these men were rare instances of a peculiar talent, which, though it thus displayed itself occasionally, was *far* too uncommon a gift to allow the possessors

* From No 73 third series of the 'Journal des Sciences Militaires,' p 99

† By Capt Sir William Denison R E

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* From No 73 third series of the 'Journal des Sciences Militaires,' p 90
† By Capt Sir William Denison R E

Fortresses, or Coast Defences, is equipped by the Department under the Director-General of Artillery at Woolwich. (See article 'Artillery,' Section II.)

The simplicity of the arrangement adapted since the peace to the nature of our Service, the avoidance of all specialities, of a train of conductors and mechanics distinct from the artillerymen, is not understood by foreigners, nor is the composition of this Service generally known at home.

Captain Jacobi, of the Prussian Service, in his work on Artillery, states:

"It is difficult to understand the composition of batteries of English artillery, as all is uncertainty and confusion in that Service. There is no positive rule for fixing the number and nature of ordnance, or determining the supply and the composition of the parks and reserves; all is abandoned to the decision of the General in Chief commanding the expedition."

It is difficult to disabuse the minds of foreigners, and explain the working of the system adopted for the British artillery, so imperfectly understood in our own Service; hence some pains have been taken here to detail the equipments, and for this purpose Tables have been framed from authentic sources.

It has been before shewn that the *personnel* of the artillery comprises one regiment for the general organization of the whole; that Woolwich is the arsenal, head-quarters, and school of instruction; that the regiment is subdivided into battalions for administrative purposes, and those again into troops and companies; the latter, forming $\frac{7}{8}$ths of the whole force, is available either for the field, garrison, coast defences, or the attack of places.

The company or troop is therefore the unit in the artillery that the battalion is to the infantry, or squadron to the cavalry; the number of companies or troops being increased or diminished for war or peace, or each may be expanded or contracted, whether for garrison or field duties.

The whole scope of instruction is therefore primarily given to perfect this unit, whose destiny is for either or many of the duties which may probably be assigned to it; and after leaving the head quarters, or school of instruction, the Captain commanding endeavours to keep it perfect for any duties which circumstances may assign to it.

The distribution of the *personnel* under the arrangement of the Deputy Adjutant-General of Artillery, depends upon the exigency of the service, but the period abroad is regulated to a certain number of years, so that the company (the horse artillery does not serve in the colonies) returns to head-quarters to be recruited, re-instructed, and made conversant with all the improvements which may have occurred in ten or twelve years.

Recurring to the subject *Equipment*, which may be said to be formed on the combination of the *Personnel* and *Materiel*—the question appears to have been well considered in 1819 by a Committee of General and Field Officers of Artillery, who entered into the experience of the previous 25 years, and it is probable that their opinion will be the basis for all future artillery equipments, with trifling modifications. The following principles are founded on the opinions of that Committee, with some observations added to explain the Tables of Equipment, and render the subject familiar to all branches of the Service.

The article "Equipment of Artillery" is given under the following heads of *Field Artillery* and *Siege Artillery*. The equipments of artillery for the "Defence of Fortresses" and "Defence of Coasts" are explained under their respective heads, as neither of these questions was considered by the Committee, nor any rule established for these equipments in our Service.*

* See Section II. paragraph 3 of article 'Artillery.'

SECTION II.—FIELD ARTILLERY.

1. *Horse Artillery*, explained in Table I., gives the equipment of four descriptions of batteries for that Service; why the Committee took into consideration the probability of 12 or 9 pounder brass guns being adopted does not appear, and they gave no opinion upon the subject further than remarking that they were not originally proposed when the horse artillery was constituted.

2. But as here suggested on examining the Tables, it will be seen that, deviating from the original intentions, the heavy equipments lose the first essential of horse artillery,—*mobility*, and its capability of acting with and supporting cavalry, besides diminishing in the application of 12 and 9 pounder guns the supply of ammunition from $\frac{1}{3}$rd to $\frac{1}{4}$th,—a point of great importance to this force, as rapidity of firing and the consequent necessary supply is next to activity of movement. It is considered, then, that the 6 pounder gun and 12 pounder howitzer should be preferred for the equipment of horse artillery.*

3. The Peace Establishment of this force would appear to comprehend everything that is necessary and adapted for an increase to that of War and active Service.

4. *Field Foot Artillery* may be said, as it now exists, to be in a state of transition, and expressly organized for a Peace Establishment. The Tables II., III. and IV. are, however, framed upon a supposed war equipment, as recommended by the Committee of Artillery Officers at the close of the last war.†

5. Table II. explains the equipment of four descriptions of foot artillery field batteries from the 9 pounder brass to the 3 pounder (both inclusive) of 6 pieces to each battery, or 5 guns and 1 howitzer, which has been deemed the most convenient combination of men, horses, and ammunition, for that armament, as regards economy and management, and is especially adapted to the unit or company upon the War Establishment.

6. The most efficient battery for this force is unquestionably the 9 pounder with the 24 pounder howitzer when the country permits the use of so heavy a field force; and as mobility is of secondary consideration with foot artillery, and as it is especially organized to act with infantry and support its movements, the *effect* of that artillery is the first essential.

7. Table III. is an equipment of reserve field batteries or batteries of position, the first comprising four heavy pieces of iron, three 18 pounder guns and one 8 inch howitzer: this force was organized in the latter campaigns of the Peninsular War for the Attack of Posts, and if associated with the heavy field batteries would make a formidable siege equipment for the Attack of Posts and *Places du moment*. The 12 pounder brass gun and the lately introduced 32 pounder howitzer form a powerful battery of reserve or position, and would at critical periods of actions be of great effect. The 9 pounder brass guns, and 24 pounder howitzers batteries of reserve are for *auxiliary* batteries to be attached or posted to infantry for special purposes, in addition to those acting with the divisions, and forming part of their strength. One, two, or more of these 9 pounder batteries of reserve, placed in battery under favourable circumstances would effect more than if divided over the field of battle attached to particular bodies where their services might not be available from the nature of the ground, or too great distance from the important point; but if kept in hand until the decisive moment arrives, as at Waterloo, when

* Notwithstanding so much has been said on this point, the value of horse artillery may be considered undiminished.—*Ed.*

† With some slight modifications in the ammunition to suit present arrangements.—*Ed.*

SECTION II —FIELD ARTILLERY.

1 *Horse Artillery*, explained in Table I, gives the equipment of four descriptions of batteries for that Service why the Committee took into consideration the probability of 12 or 9 pounder brass guns being adopted does not appear, and they gave no opinion upon the subject, further than remarking that they were not originally proposed when the horse artillery was constituted

2 But as here suggested, on examining the Tables, it will be seen that, deviating from the original intentions, the heavy equipments lose the first essential of horse artillery,—*mobility*, and its capability of acting with and supporting cavalry, besides diminishing in the application of 12 and 9 pounder guns the supply of ammunition from ⅓rd to ¼th,—a point of great importance to this force, as rapidity of firing and the consequent necessary supply is next to activity of movement It is considered, then, that the 6 pounder gun and 12 pounder howitzer should be preferred for the equipment of horse artillery *

3 The Peace Establishment of this force would appear to comprehend everything that is necessary and adapted for an increase to that of War and active Service

4 *Field Foot Artillery* may be said, as it now exists, to be in a state of transition, and expressly organized for a Peace Establishment The Tables II III and IV are, however, framed upon a supposed war equipment, as recommended by the Committee of Artillery Officers at the close of the last war †

5 Table II explains the equipment of four descriptions of foot artillery field batteries, from the 9 pounder brass to the 3 pounder (both inclusive) of 6 pieces to each battery, or 5 guns and 1 howitzer, which has been deemed the most convenient combination of men, horses, and ammunition, for that armament, as regards economy and management, and is especially adapted to the unit or company upon the War Establishment

6 The most efficient battery for this force is unquestionably the 9 pounder with the 24 pounder howitzer, when the country permits the use of so heavy a field force, and as mobility is of secondary consideration with foot artillery, and as it is especially organized to act with infantry and support its movements, the *effect* of that artillery is the first essential

7. Table III is an equipment of reserve field batteries, or batteries of position, the first comprising four heavy pieces of iron, three 18 pounder guns, and one 8 inch howitzer this force was organized in the latter campaigns of the Peninsular War for the Attack of Posts, and if associated with the heavy field batteries would make a formidable siege equipment for the Attack of Posts and *Places du moment* The 12 pounder brass gun and the lately introduced 32 pounder howitzer form a powerful battery of reserve or position, and would at critical periods of actions be of great effect The 9 pounder brass guns, and 24 pounder howitzers, batteries of reserve, are for *auxiliary* batteries, to be attached or posted to infantry for special purposes, in addition to those acting with the divisions, and forming part of their strength One two, or more of these 9 pounder batteries of reserve, placed in battery under favourable circumstances, would effect more than if divided over the field of battle, attached to particular bodies where their services might not be available from the nature of the ground, or too great distance from the important point, but if kept in hand until the decisive moment arrives, as at Waterloo, when

* Notwithstanding so much has been said on this point the value of horse artillery may be considered undiminished —*Ed*

† With some slight modifications in the ammunition to suit present arrangements —*Ed*

TABLE I

Equipment of Royal Horse Artillery Batteries for Service for either of the following Brass Ordnance

Nature of Equipment	12 pr Gun and 24 pr Howitzer Battery			9 pr Gun and 24-p Howitzer Battery			Light 6 pr Gun and 12 pr Howitzer Battery			Heavy 3 pr Gun and 12 pr Howitzer Battery			Remarks
	Gun	Howitzer	Total	Gun	Howitzer	Total	Gun	Howitzer	Total	Gun	Howitzer	Total	
Ordnance													See Artillery Plates I & II and Artillery Tables D E and F
Guns	5		5	5		5	5		5	5		5	
Howitzers		1	1		1	1		1	1		1	1	
Total pieces of Ordnance			6			6			6			6	
Establishment													
Captains			2			2			2			2	
Subalterns			3			3			3			3	
Staff Serjeants			2			2			2			2	
Serjeants			3			3			3			3	
Corporals			3			3			3			3	
Bombardiers			8			7			6			6	
Gunners	10	10	96	9	9	90	8	8	80	8	8	80	
Trumpeter			1			1			1			1	
Farrier			1			1			1			1	
Carriage Smith			1			1			1			1	
Shoeing			5			4			3			3	
Collar makers			2			2			2			2	
Wheelers			2			2			1			1	
Drivers Serjeant			1			1			1			1	
Corporals			4			4			3			3	
Privates			93			80			69			65	
Medical Officer			1			1			1			1	
Total Establishment			228			207			182			178	
Carriages													See Plates of article Carriage
Gun and Howitzer carriages	5	1	6	5	1	6	5	1	6	5	1	6	
Gun and Howitzer spare do	1		1	1		1	1		1	1		1	
Store waggons			2			1			1			1	
cart			1			1			1			1	
Forge waggon			1			1			1			1	
Ammunition waggons	10	2	12	7	2	9	6	2	8	5	2	7	
Total Carriages			23			19			18			17	
Horses													This includes spare horses at $\frac{1}{10}$ per battery
Riding			79			78			64			64	
Draught	10	10	160	8	8	135	6	6	115	6	6	108	
Baggage			7			7			7			7	
Total Horses			246			220			186			179	
Ammunition													
Round	120		600	$121\frac{3}{5}$		608	17[illegible]		863	[illegible]2		1360	
Case	14	12	8[illegible]	$19\frac{1}{5}$	12	108	21	12	117	41	12	232	
Spherical do.	50	72	322	$25\frac{1}{5}$	72	[illegible]00	30	118	[illegible]64		118	118	
Shells		56	56		56	56		98	9[illegible]		98	98	
Carcasses		4	4		4	4		8	8		8	8	
Total Ammunition			1064			976			1354			1816	

and which may be occasioned by the neophyte state of that arm of the Artillery. Already the rocket carriage (see Plate in the article 'Carriage') has become obsolete.

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of manœuvres, to enable it to face the enemy's fire with the fewest chances of destruction. It should, therefore, be thrown forward in skirmishing order, but prepared to rapidly concentrate and charge at a moment's notice. The part which infantry at present is here invested in, it becomes but the auxiliary of the rockets, or rather the latter becomes its arm *par excellence*, while the firelocks dwindle down to mere accessories for the purpose of repelling an attack.

"Under this new system the instruction of infantry will be not only different, and must be divided into two parts—the first, told off for the service of the rockets; the second, to support or act as a rallying point to the former when in immediate contact with the enemy. The proportion of arms as it now exists will undergo a change. More cavalry and less infantry will be required—the former drilled in a special manner. There will be also required, if I may be permitted to use the expression, an *infantry-artillery* for the rocket service, destined for the occupation of intrenched posts, the defence of fortresses, and the operations of mountain warfare.* But these projectiles acquire a vast importance under a thousand circumstances where guns are perfectly useless. In the mountains it is with the greatest difficulty that a small number of light guns, which produce but inconsiderable effect, can be transported. But the rocket combines extended range with multiplied fire. It may be established everywhere, on the crests of the highest peaks or on the lower plateaux of mountains. In the plains it converts every house into a fortress, and the roof of a village church is rendered at will the platform of a formidable battery. In one word, this invention, such as it now exists, and susceptible as it still is of further elaboration, adapts itself to every variety of circumstance, to every possible combination, and must exercise an immense influence on the destinies of armies.

"If, however, Congreve rockets are served by a special corps, if they are considered purely in the light of artillery, they will be so circumscribed in number, that their effect would be inconsiderable. It is by giving to them an immense development that their extraordinary powers can alone be brought into their fullest operation, and for that purpose they must be made the general arm of an army. Man reflects but little on the nature of things. He is governed by the opinions and decisions of others, moves in a vicious circle of monotonous uniformity, without ever exercising his intelligence on the work of alteration or improvement. Thus it will be long before the power of Congreve rockets will be felt and appreciated. But if, on the outbreak of the first war, a General of distinguished ability views the question in all its bearings—embraces all the consequences that may be derived from it—if he prepares in silence his means to deploy them on the first field of battle, his success will be such that, until the enemy shall employ the same, he will prove irresistible. At the moment of making this grand experiment, the genius of the General in Chief will exercise a great ascendancy on the fate of the war.

"But although the calculations of reason and foresight all appear to justify the results I have foretold, still experience alone can incontestably establish the merit of this new invention. There are so many unforeseen events which modify the most prudential foresight, the most seductive prospects, that a man of sense and prudence will not be thoroughly convinced until facts have, in the most absolute manner, realized his hopes. Nevertheless I must repeat that the probability is so strong, and presents itself in so conclusive a shape, that a skilful General ought, on the outbreak of the first war, to prepare for the employment of this new weapon in the way I have explained, to disconcert and astonish his adversary by its effects. If he alone makes use of it, in all probability he will remain master of the field. If, on the other hand, the enemy should have displayed equal prudence and foresight, he will escape the certainty of becoming his victim. But this vigilance and forethought ought beforehand to embrace not only the immediate employment of this new means, but also all the consequences that may result from it relatively to the other arms, to their proportions, their manœuvres, and their employments. It is evident that, after the first successful application of the Congreve rocket in a campaign, it will be adopted in all the armies of Europe. An equilibrium will be then established—all exclusive advantage set aside. But the art of war will undergo a singular modification, the moral effect of battles will be greater, their action more decided, and the effusion of blood will be consequently less. For in war it is not the number of men who are killed, but the number who are terrified, which is the guarantee of victory. I therefore again repeat, that Congreve rockets will produce a revolution in the art of war. They will redound to the glory and profit of the General who will the first comprehend their importance and skilfully avail himself of all the advantages to be derived from them."

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* More especially in Canada, where the numerous rivers and lakes render the movements of artillery always difficult, and at times impossible. The carcass rocket seems particularly applicable to the destruction of blockhouses on isolated points, rendered inaccessible to guns by the surrounding forests, swamps, &c. of an unreclaimed country. See 'Mountain Artillery' in vol. ii.

TABLE I

Equipment of Royal Horse Artillery Batteries for Service for either of the following Brass Ordnance

Nature of Equipment	12 pr Gun and 24 pr Howitzer Battery			9 pr Gun and 24 pr Howitzer Battery			Light 6 pr Gun and 12 pr Howitzer Battery			Heavy 3 pr Gun and 12 pr Howitzer Battery			Remarks
	Gun	Howitzer	Total	Gun	Howitzer	Total	Gun	Howitzer	Total	Gun	Howitzer	Total	
Ordnance													
Guns	5		5	5		5	5		5	5		5	See Artillery Plates I & II
Howitzers		1	1		1	1		1	1		1	1	and Artillery Tables D E
Total pieces of Ordnance			6			6			6			6	and F
Establishment													
Captains			2			2			2			2	
Subalterns			3			3			3			3	
Staff Serjeants			2			2			2			2	
Serjeants			3			3			3			3	
Corporals			3			3			3			3	
Bombardiers			8			7			6			6	
Gunners	10	10	96	9	9	90	8	8	80	8	8	80	
Trumpeter			1			1			1			1	
Farrier			1			1			1			1	
Carriage Smith			1			1			1			1	
Shoeing			5			4			3			3	
Collar makers			2			2			2			2	
Wheelers			2			2			1			1	
Drivers, Serjeant			1			1			1			1	
„ Corporals			4			4			3			3	
„ Privates			93			80			69			65	
Medical Officer			1			1			1			1	
Total Establishment			228			207			182			178	
Carriages													
Gun and Howitzer carriages	5	1	6	5	1	6	5	1	6	5	1	6	
Gun and Howitzer spare do	1		1	1		1	1		1	1		1	
Store waggons			2			1			1			1	See Plates of article Carriage
„ cart			1			1			1			1	
Forge waggon			1			1			1			1	
Ammunition waggons	10	2	12	7	2	9	6	2	8	5	2	7	
Total Carriages			23			19			18			17	
Horses													
Riding			79			78			64			64	This includes
Draught	10	10	160	8	8	135	6	6	115	6	6	108	spare horses
Baggage			7			7			7			7	at $\frac{1}{10}$ per battery
Total Horses			246			220			186			179	
Ammunition													
Round	120		600	$121\frac{3}{5}$		608	$172\frac{3}{5}$		863	272		1360	
Case	14	12	82	$19\frac{1}{5}$	12	108	21	12	117	44	12	232	
Spherical do.	50	72	322	$25\frac{3}{5}$	72	200	30	118	268		118	118	
Shells		56	56		56	56		98	98		98	98	
Carcasses		4	4		4	4		8	8		8	8	
Total Ammunition			1064			976			1354			1816	

TABLE V—*continued*

Ordnance and Implements	Guns 24 pr	Guns 12 pr	Howitzers 10-in	Howitzers 8 in	Mortars 10 in	Mortars 8 in	Mortars 5½ in	Mortars 4⅖ in	
Copper powder measures {4 lb to 1 oz. sets}	8	4	1	2	2	3			
Copper scales with beams									A set for 5 pieces
Brass weights, 4 lb piles					2	3	2	2	1 in 5 for large mortars 1 in 10 for small ditto
Mallets					2	3	2	2	Ditto ditto
Setters			5	10	10	15	20	20	{1 mallet and 2 setters for each mortar and howitzer
Tenon saws			10	20	20	30	40	40	
Setters for saws	20	10	3	5	5	8	10	10	1 for every 2 pieces
Files 3 square	20	10	3	5	5	8	10	10	
Quadrants brass	20	10	3	5	5	8	10	10	
Perpendiculars			1	2	2	3			
Box rules			1	2	2	3			{1 for every five 10 inch and 8 inch mortars and howitzers
Compasses	8	4	1	2	2	3			
			1	2	2	3			A rule for 5 pieces
Funnels {tin for filling	10	5	3	5	5	8	10	10	1 for 5 mortars and howitzers
Funnels {ditto for loading									{1 in 4 for guns 1 in 2 for mortars and howitzers
Corkscrews					5	8			1 in 2 for large mortars
Engines for drawing fuzes	10	5	3	5	5	8	10	10	{1 in 4 for guns, 1 in 2 for mortars and howitzers
Pincers pairs iron			1	2	2	3	"		
Scrapers for shells	8	4					4	4	1 in 5
Lead plummets	"		3	5	5	8	10	10	1 in 3
Shell hooks pairs hand					10	13	20	20	
Cartouches of leather large			10		20	"			
Budge barrels	40	20	5	10	10	15	20	20	
Blue lights			5	10	10	15	5	5	{1 for each large mortar and howitzer and 1 for 4 small mortars
Hazel hoops for powder barrels				One hundred					For signals
Copper {adzes									
Copper {drivers		"						"	A hoop for 10 barrels if used
Copper {vices	"							"	{A set for every 500 barrels of powder if barrels are used
Copper {can hooks, pairs with slings							"		

TABLE V.—*continued.*

Spare Transporting and other Carriages, &c., for Battering Train.

	Spare Carriages for Ordnance: 24 pounders	12 pounders	10 inch howitzers	8 inch howitzers	Waggons: Flanders pattern	Store	Forge	Carts: Hand and Shafts	Sling	Trench	Carriages: Devil, Large	Devil, Small	Platform	Drag, Large	Drag, Small	
No. of carriages	4	2	1	1	100	10	10	50	10	50		2	25	5	5	1 spare carriage for 10 pieces of ordnance.
Covers { waggon, painted					100											
Covers { cart, do.								50								
Grease boxes	4	2	1	1	100	10	10						25			
Jacks { hand screw, large													6			1 for 4 platform waggons
Jacks { lifting					20	2	2									1 " 5 for waggons
Linch pins, spare																1 per carriage
Chests of tools, with anvils, blocks and beak irons																Forges to be completed with these articles

Horse Harness for Carriages.

Horse harness complete, with whips, leggings, head stall, halters, &c.	24 pounders	12 pounders	10 inch howitzers	8 inch howitzers	Flanders pattern	Store	Forge	Hand and Shafts	Sling	Trench	Devil, Large	Devil, Small	Platform	Drag, Large	Drag, Small	Single Wheel	Single Draft	General Total	
wheel	8	4	2	2	200	20	20						50		"	306		306	18 platform waggons at 8 horses each for the mortars, and the remaining 7 at 4 horses each.
leader	10	4	4	2	200	20	20						122				388	388	
off wheel			"					50		50						100		100	

Horse Harness for Ordnance.

Horse harness complete, with whips, leggings, head stall, halters, with chain reins, &c.

	Forty 24 prs. at 12 Horses	Twenty 12 prs. at 6 Horses	Five 10 inch Howitzers at 12 Horses	Ten 8 inch Howitzers at 6 Horses	Single Wheel	Single Draft	General Total	
Wheel	80	40	10	20	150		150	No spare harness necessary with battering equipments, as the whole of the allotted proportions can hardly under any circumstances be expected to be in use at once.
Leader	320	80	40	40		480	480	
General Total Harness					556	868	1424	

TABLE V—*continued*

Ordnance and Implements	Guns 24 pr	Guns 12 pr	Howitzers 10 in	Howitzers 8 in	Mortars 10-in	Mortars 8-in	Mortars 5½ in	Mortars 4⅖ in	
Copper powder measures { 4 lb to 1 oz. sets }	8	4	1	2	2	3			A set for 5 pieces.
Copper scales with beams					2	3	2	2	1 in 5 for large mortars 1 in 10 for small ditto.
Brass weights 4 lb piles					2	3	2	"	Ditto ditto.
Mallets			5	10	10	15	20	20	{ 1 mallet and 2 setters for each mortar and howitzer
Setters			10	20	20	30	40	40	
Tenon saws	20	10	3	5	5	8	10	10	1 for every 2 pieces.
Setters for saws	20	10	3	5	5	8	10	10	
Files 3 square	20	10	3	5	5	8	10	10	
Quadrants brass			1	2	2	3			
Perpendiculars			1	2	2	3		"	{ 1 for every five 10-inch and 8 inch mortars and howitzers.
Box rules	8	4	1	2	2	3			
Compasses			1	2	2	3	"		A rule for 5 pieces.
Funnels { tin for filling	10	5	3	5	5	8	10	10	1 for 5 mortars and howitzers.
Funnels { ditto for loading				"	5	8			{ 1 in 4 for guns; 1 in 2 for mortars and howitzers
Corkscrews								"	1 in for large mortars.
Engines for drawing fuzes	10	5	3	5	5	8	10	10	{ 1 in 4 for guns; 1 in 2 for mortars and howitzers
Pincers pairs iron			1	2	2	3			1 in 5
Scrapers for shells	8	4			"		" 4	4	1 in 5
Lead plummets			3	5	5	8	10	10	
Shell hooks pairs hand					10	15	20	20	
Cartouches of leather large			10		20	"			
Budge barrels	40	20	5	10	10	15	20	20	
Blue lights	"	"	5	10	10	15	5	5	{ 1 for each large mortar and howitzer, and 1 for 4 small mortars
Hazel hoops for powder barrels				One hundred					For signals.
Copper { adzes									A hoop for 10 barrels if used
Copper { livers	"			"		"			
Copper { ces									
Copper { can hooks, pairs with slings									{ A set for every 500 barrels of powder if barrels are used

TABLE V.—continued.

Spare Transporting and other Carriages, &c. for Battering Train.

	Spare Carriages for Ordnance: 24-pounders	12-pounders	10-in hows	8-in hows	Waggons: Flanders pattern	Store	Forge	Carts: Hand with shafts	Sling	Trench	Carriages: Devil, Large	Devil, Small	Platform	Drag, Large	Drag, Small	
No. of carriages	4	2	1	1	100	10	10	50	10	50		2	25	5	5	1 spare carriage for 10 pieces of ordnance.
Covers { waggon painted					100											
Covers { cart do								50	„							
Grease boxes	4	2	1	1	100	10	10						25	„	„	
Jacks { hand screw large								„					6			1 for 4 platform waggons.
Jacks { lifting					20	2	2				„					1 in 5 for waggons.
Linchpins spare																1 per carriage.
Chests of tools with anvils, blocks and beak irons	}															{ Forges to be completed with these articles.

Horse Harness for Carriages	24-pounders	12-pounders	10-in hows	8-in hows	Flanders pattern	Store	Forge	Hand with shafts	Sling	Trench	Devil, Large	Devil, Small	Platform	Drag, Large	Drag, Small	Single Wheel	Single Draft	General Total	
Horse harness complete with whips, leggins, head stall, halters, &c. — wheel	8	4	2	2	200	20	20		„		„		50		„	306	„	306	In platform waggons at 8 horses each for harness, and the remaining 7 at 4 horses each.
— leader	16	4	4	2	200	20	20						122				388	388	
— off wheel			„					50		50						100		100	

Horse Harness for Ordnance		Forty 24 prs. at 10 horses	Twenty 12 prs. at 6 horses	Four 10-inch Howitzers at 10 horses	Ten 8-inch Howitzers at 6 Horses	Single Wheel	Single Draft	General Total	
Horse harness complete with whips, leggins, head stall, halters, with chain reins, &c.	Wheel	80	40	10	20	150		150	No spare harness necessary with bearing equipment, as the whole of the allotted proportions can hardly under any circumstances be expected to be in use at once.
	Leader	320	80	40	40		480	480	
			General Total Harness			556	868	1424	

TABLE V.—*continued.*

Ordnance and Implements	Guns. 24 pr.	Guns. 12 pr	Howitzers 10 in.	Howitzers 8 in.	Mortars 10-in.	Mortars 8-in.	Mortars $5\frac{1}{2}$ in.	Mortars $4\frac{2}{5}$ in.	
Copper powder measures { 4 lb to 1 oz. sets }	8	4	1	2	2	3	"	"	A set for 5 pieces.
Copper scales with beams	"	"	"	"	2	3	2	2	1 in 5 for large mortars; 1 in 10 for small ditto.
Brass weights, 4-lb. piles	"	"	"	"	2	3	2	2	Ditto. ditto.
Mallets	"	"	5	10	10	15	20	20	1 mallet and 2 setters for each mortar and howitzer.
Setters	"	"	10	20	20	30	40	40	
Tenon saws	20	10	3	5	5	8	10	10	1 for every 2 pieces.
Setters for saws	20	10	3	5	5	8	10	10	
Files, 3-square	20	10	3	5	5	8	10	10	
Quadrants, brass	"	"	1	2	2	3	"	"	
Perpendiculars	"	"	1	2	2	3	"	"	1 for every five 10-inch and 8-inch *mortars and* howitzers.
Box rules	8	4	1	2	2	3	"	"	A rule for 5 pieces.
Compasses	"	"	1	2	2	3	"	"	1 for 5 mortars and howitzers.
Funnels { tin for filling	10	5	3	5	5	8	10	10	1 in 4 for guns; 1 in 2 for mortars and howitzers.
Funnels { ditto for loading	"	"	"	"	5	8	"	"	1 in 2 for large mortars.
Corkscrews	10	5,	3,	5,	5	8	10	10	1 in 4 for guns; 1 in 2 for mortars and howitzers.
Engines for drawing fuzes	"	"	1	2	2	3			
Pincers, pairs, iron	8	4					"	"	1 in 3.
Scrapers for shells	"	"	"	"	"	"	4	4	1 in 5.
Lead plummets	"	"	3	5	5	8	10	10	
Shell-hooks, pairs, hand	"	"	"	"	10	15	20	20	
Cartouches of leather, large	"	"	10	"	20	"	"	"	
Budge barrels	40	20	5	10	10	15	20	20	
Blue lights	"	"	5	10	10	15	5	5	1 for each large mortar and howitzer, and 1 for 4 small mortars.
Hazel hoops for powder barrels	One hundred.								For signals.
Copper { adzes	"	"	"	"	"	"	"	"	A hoop for 10 barrels, if used.
Copper { drivers	"	"	"	"	"	"	"	"	A set for every 500 barrels of powder, if barrels are used.
Copper { vices	"	"	"	"	"	"	"	"	
Copper { can-hooks, pairs, with slings	"	"	"	"	"	"	"	"	
	"	"	"	"	"	"	"	"	

TABLE V.—*continued.*

Spare Transporting and other Carriages, &c. for Battering Train.

	Spare Carriages for Ordnance: 24 pounders	Spare Carriages for Ordnance: 12 pounders	Spare Carriages for Ordnance: 10 in how rs	Spare Carriages for Ordnance: 8 in howitz	Waggons: Flanders pattern	Waggons: Store	Waggons: Forge	Carts: Hand with shafts	Carts: Sling	Carts: Trench	Carriages: Devil: Large	Carriages: Devil: Small	Carriages: Platform	Carriages: Drag: Large	Carriages: Drag: Small	Single Wheel.	Single Draft.	General Total.	
No. of carriages	4	2	1	1	100	10	10	50	10	50		2	25	5	5				1 spare carriage for 10 pieces of ordnance.
Covers { waggon painted					100														
Covers { cart do.								50	"										
Grease boxes	4	2	1	1	100	10	10		"			"	25	"	"				
Jacks { hand-screw large							"	"	"				6						1 for 4 platform waggons.
Jacks { lifting					20	2	2				"	"							1 in 5 for waggons.
Linch pins spare			"			"									"				1 per carriage.
Chests of tools with anvils, blocks and beak irons	}																		{ Forges to be completed with these articles.
Horse Harness for Carriages.																			
Horse harness complete with whips, leggings, head stall halters, &c. { wheel	8	4	2	2	200	20	20		"				50		"	306	"	306	12 platform waggons at 8 horses each for the mortars, and the remaining 7 at 4 horses each.
{ leader	16	4	4	2	200	20	20						122				388	388	
{ off wheel			"					50		50				"	"	100	"	100	

Horse Harness for Ordnance.

Horse harness complete with whips, leggings, head stall halters, with chain reins, &c.

	Forty 24 prs at 10 Horses	Twenty 12 prs at 6 Horses	Five 10 inch Howitzers at 10 Horses	Ten 8 inch Howitzers at 6 Horses	Single Wheel.	Single Draft.	General Total.	
Wheel	80	40	10	20	150		150	No spare harness necessary with battering equipments, as the whole of the allotted proportions can hardly, under any circumstances, be expected to be in use at once.
Leader	320	80	40	40		480	480	
General Total Harness					556	868	1424	

TABLE V—*continued*

Ordnance and Implements	Guns		Howitzers		Mortars				
	24 pr	12 pr	10 in	8 in	10 in	8 in	$5\frac{1}{2}$ in	$4\frac{2}{5}$ in	
Copper powder measures { 4 lb to 1 oz sets }	8	4	1	2	2	3	"	"	A set for 5 pieces.
Copper scales with beams	"	"	.	"	2	3	2	2	1 in 5 for large mortars, 1 in 10 for small ditto.
Brass weights, 4 lb piles	"	"	"	"	2	3	2	2	Ditto, ditto.
Mallets	"	"	5	10	10	15	20	20	{ 1 mallet and 2 setters for each mortar and howitzer
Setters		.	10	20	20	30	40	40	
Tenon saws	20	10	3	5	5	8	10	10	1 for every 2 pieces
Setters for saws	20	10	3	5	5	8	10	10	
Files 3 square	20	10	3	5	5	8	10	10	
Quadrants brass	"	"	1	2	2	3	"	"	
Perpendiculars	"	"	1	2	2	3	"	"	{ 1 for every five 10 inch and 8 inch mortars and howitzers.
Box rules	8	4	1	2	2	3	"	"	A rule for 5 pieces
Compasses	"	"	1	2	2	3	"	.	1 for 3 mortars and howitzers.
Funnels { tin for filling	10	5	3	5	5	8	10	10	{ 1 in 4 for guns, 1 in 2 for mortars and howitzers
Funnels { ditto for loading	"	"	"	.	5	8	"	"	1 in 2 for large mortars.
Corkscrews	10	5	3	5	5	8	10	10	{ 1 in 4 for guns; 1 in 2 for mortars and howitzers
Engines for drawing fuzes		.	1	2	2	3	"	.	1 in 5
Pincers pairs iron	8	4	"	"	"	.	4	1	1 in 5
Scrapers for shells	"	"	3	5	5	8	10	10	
Lead plummets		"		"	10	15	20	20	
Shell hooks pairs hand	.	.	10		20	.	.	"	
Cartouches of leather large	40	20	5	10	10	15	20	20	
Budge barrels	"	"	5	10	10	15	5	5	{ 1 for each large mortar and howitzer, and 1 for 4 small mortars
Blue lights			One hundred						For signals
Hazel hoops for powder barrels	.	.	"	"	.	"	.	"	A hoop for 10 barrels, if used
Copper { adzes	.	.	"	.	"	"	"	"	} A set for every 500 barrels of powder, if barrels are used
Copper { drivers	.	.	"	"	"	"	"	"	
Copper { vices	.	.	"	.		.	.	"	
Copper { can hooks pairs with slings	.	"	"	.	"	"	"	"	

TABLE VI.—*continued.*

	Total sent from England.	Left at St. Sebastian	Expended at the Siege
Portfires, blue paper	256	176	67
Portfire sticks	294	„	82
Tube boxes	292	13	39
Cutting knives	156	17	51
Scissars	156	17	49
Worsted	lbs oz 21 3½	„	„
Needles	398	„	118
Thumbstalls	276	„	73
Flax, lbs.	67	„	7
Tow	lbs. oz. 19 2	„	lbs. oz 4 2
Mallets and setters	60 : 132	„	8 : 37
Files	248	„	23
Rasps	62	„	18
Tenon saws	56	„	„
Diagonal scales	130	„	46
Coarse twine, lbs	144	„	69
Perpendiculars	58	„	18
Quadrants, brass	58	„	2
Compasses, brass	61	„	7
Pincers, pairs, copper	98	„	29
Pincers, pairs, iron	29	„	4
Copper salting boxes	28	„	3
Corkscrews	130	„	24
Spoke-shaves	58	„	5
Wood vices	98	„	8
Fuze augers	92	„	17
Funnels, copper	48	„	„
Funnels, tin	80	„	7
Funnels, tin, for loading mortars	24	„	„
Copper powder measures, 4 lbs	45	8	„
Copper powder measures, 2 lbs.	65	8	„
Copper powder measures, 1 lb	56	8	1
Copper powder measures, 8 oz.	44	„	4
Copper powder measures, 4 oz.	42	„	1
Copper powder measures, 2 oz.	40	„	„
Copper powder measures, 1 oz.	40	„	1
Dutch thread, lbs	168	„	60
Scrapers for shells	37	„	„
Cartouches of leather, large	330	30	108
Sheepskins	110	„	47
For spherical fuzes. Tin boxes, white	96	„	5
For spherical fuzes. Tin boxes, blue	96	„	5
For spherical fuzes. Tin boxes, black	96	„	5
For spherical fuzes. Canvas bags, yellow	96	„	4
For spherical fuzes. Canvas bags, red	96	„	4
For spherical fuzes. Canvas bags, green	96	„	4
Leather straps for boxes	118	„	46
Leather straps for bags	118	„	46

TABLE VI—*continued*

	Total sent from England	Left at St Sebastian	Expended at the Siege
Fuzes common 13 inch	1 900		,,
Fuzes common 10	18 450		5 495
Fuzes common 8	30 000		10 440
Fuzes spherical *8 inch* uncut	9 000		3 000
Fuzes spherical *8 inch* cut	54 000		4 120
Fuzes spherical 5½ uncut	24 700		3 948
Fuzes spherical 5½ cut	10 598		
Quick match lengths	180 201		
Engines for drawing fuzes	28		
Shell hooks pairs	72		15
Tangent scales brass	,,		
Lead plummets	27		
Copper scales with beams	28		
Brass weights sets 4 lbs to ¼ oz.	30		
2 lbs to ¼ oz.	4		2

General Stores

	Total sent from England	Left at St Sebastian	Expended at the Siege
Triangle gyns complete with blocks &c	16	1	3
Triangle gyns incomplete			,,
Cambeons*		,,	
White rope Fathoms 6 inch	38		,,
White rope Fathoms 4	98	,,	
White rope Fathoms 2½	1 130	,,	
White rope Fathoms 1	130	,,	,,
White rope Coils 6½	2	,,	1
White rope Coils 6	1		,,
White rope Coils 5	,,	,,	,,
White rope Coils 4½	5		,,
White rope Coils 4	4		2
White rope Coils 3½	4		,,
White rope Coils 2½	65	,,	20
White rope Coils 1	16		5
White rope Coils ½	15	,,	5
Tarred rope ends old			,,
Tarred rope coils 4½ inch	7		2½
Tarred rope coils 3 ,,	5	,,	1
Tarred rope coils 2 ,,	5	,,	1
Tarred rope coils 1	9	,,	2
Purchase blocks with brass sheaves treble	5	,,	,,
Purchase blocks with brass sheaves double	5	,,	,,
Purchase blocks with brass sheaves single	4	,,	,,
Spun yarn coils	16	,,	3
Ratline ditto	8	,,	2
Grates for heating shot complete with tongs &c.	13	,,	,,
Junk cwts.	94	,,	,,
Coals chaldrons	13	,,	6
Candles lbs	896	,,	250
Crab capstan complete	1	,,	,,

* The long wooden joints of the centre chain of bullock harness.

TABLE VI—*continued*

		Total sent from England	Left at St Sebastian	Expended at the Siege
Union flags,	large	8		1
	small jacks	8		2
Ordnance jacks		8		1
Flag staves		8		1
Brass callipers large pairs		7		
Screws of sorts grosses		46		10
Tacks of sorts	in No	65 000		
	in weight	lbs oz 10 12		
Nails in No	Clasp 40 penny	22 000		
	Clasp 30	29 250		
	Clasp 20	50 400		
	Clasp 10 „	45 500		
	Clasp 8	40 000		
	Clasp 6 „	44 000		„
	Clout 6	21 000		
	Clout 4	22 000	„	
	Clout 3 „	13 000		
	Clout 2	43 000		
	Streaks of sorts	8 500		
		cwt qrs lbs		cwt qrs lbs
Nails in weight	Clasp 40 penny	15 0 8		10 2 24
	Clasp 30 „	4 0 24		
	Clasp 20 „	10 3 0		8 2 20
	Clasp 10	2 1 8		2 0 16
	Clasp 8 „	3 2 8		1 3 4
	Clasp 6	2 2 0		1 1 0
	Clout, 4	1 1 10		0 3 26
	Clout, 3	0 0 25		0 0 12¼
	Clout, 2	0 2 14		0 1 2
Tire nails	24 pounder carriages	4 500		3,380
	8 inch howitzers	1 200		600
	6 pounders heavy	1 400	„	
	6 pounders light	200	„	
Spades		204		50
Shovels		84		20
Axes	Felling	204		50
	Broad	84		20
	Pick	204		50
Hand	Hatchets	200		50
	Bill	204		50
Spare helves of sorts		300		„
Grindstones, with troughs		8		2
Hand-barrows,	double	20	„	
	single	80	„	20
Saws	Sash	74	„	24
	Hand	100	„	40
	Pit	12		3
	Cross-cut	22	„	4
Setters for ditto dozens	Hand	100	„	40
	Pit	12	„	3
Setters for cross-cut saws dozens		24	„	6

TABLE VI.—*continued.*

	Total sent from England	Left at St Sebastian	Expended at the Siege
Files for cross-cut saws, dozens — Sash	2		1
Hand	100	"	40
Pit	11		3
Cross-cut	21		6
Pin mauls	7		"
Wood mauls	5		
Linchpins	7		
Camp colours	80		30
Oak skidding, 8 x 8 inches, feet running	800½		185
Deals, feet running — 3 inch	4 110		690
2 "	200		
1½ "	421		112
1¼ "	168		56
1 "	401		108
¾ "	408		108
½ "	412		100
Plank, feet superficial — Ash 2½ inch	2 000		399
Ash 2 "	2 000		82
Elm 1½	2 000		1 000
Elm 1¼	2 000	"	995
Elm 1	1 995		1 000
Spare in the rough — Spokes	850		231
Bars — fore	473		44
hind	397		60
splinter	205		10
sweep	48		12
master	80		20
Axletrees	25		5
Naves	40		10
Shafts — heavy	4		
light	4		
Under poles	40		10
Tail pieces	80		
Guides — fore	19		5
hind	21		5
Axletree beds	40		10
Nose bags	530		
Forage cords, sets	206		8
Shoeing tools, sets	2		2
Swingletrees	80		20

Collar makers' Materials.

	Total sent from England	Left at St Sebastian	Expended at the Siege
Hides — Black — heavy	13	"	"
light	14	"	"
Brown — heavy	8	"	"
light	8	"	"
Seat	5	"	½
White horse	7	"	
Baskets, dozens — black	28		"
brown	22		"

"The guns proposed are,

"First The present 32 pounder, weight 57 cwt, charge 10 lbs	When mounted on lower decks of line-of battle ships
"Secondly Modified* 32 pounders, weight 42 cwt (equal to present 18 pounder), charge 5 or 6 lbs	Main decks and in frigates and hollow shot when close, or charge equal to 1 round grape and 1 round shot
"Thirdly Second class modified* 32 pounders; weight 25 cwt., charge 3½ or 4 lbs	Quarter decks, forecastle of frigates and line-of battle ships decks of 18 gun brigs and all smaller vessels"

It may be assumed, therefore, that the principle laid down in the foregoing Memorandum has been happily adopted, by referring to Table I, and thus the confusion incident to guns of several calibres being placed in one vessel avoided, and the power of the armament greatly increased.

It must be admitted that there is a maximum calibre at which the shot is capable of penetrating the sides of ships of war, and destroying everything it meets, combined with the facility of working the piece of ordnance adapted to naval armaments, and the armament of coast defences, and that is considered to be the 32 pounder gun, as preferable for broadside guns The 42, 56, 68, and 84 pounder guns, no doubt valuable for special cases, will make a larger hole in the sides of a vessel, and a corresponding destruction; but as the weight and length are increased, so the celerity of fire decreases, and a number of men to work these heavy pieces of ordnance must be added

It is therefore to be wished that these ponderous and unwieldy descriptions of ordnance should be limited in naval warfare to a few in each vessel. About one tenth of the whole armament as will be seen in Table I, is now established as a principle

These remarks are induced from a desire evinced by some influential persons, of arming vessels of war with the 42 pounder gun The French seem disposed to abandon their 36 pounder, and adopt the 30 pounder of 6.457 inches diameter, English measure †

See 'Artillery' Tables A B C D

The Tables to the article 'Artillery' will give the weights and dimensions of the several pieces of ordnance now used in the armament of ships of war Table II of this article gives their ranges It has been explained in 'Artillery' that the Ordnance Department supply all artillery stores, ammunition, and guns to the Navy, and hence the advantage to the Service generally for a perfect knowledge of the description and nature of these articles.

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* This 'Modification' to suit different vessels or different decks in the same vessel has been in some respects met by the introduction of Monk's A B C 32-pounders —and in others by the 24 pounder and 18 pounder 'bored up' to the same calibre See 'Artillery' Table A.—*Editors*

† Since these remarks were suggested the 8 inch gun has been generally introduced into the Navy in the proportion of one tenth of the whole armament

TABLE I

Proportion of Ordnance to be issued to Her Majesty's Ships

Ordnance	Weight (Cwts.)	Length (ft in)	First Rate: [illegible] Guns	First Rate: 120 Guns	First Rate: [illegible] Guns	First Rate: 120 Guns	Second Rate: 100 Guns (1st Class)	Second Rate: 90 Guns	Second Rate: 90 Guns	Second Rate: 80 Guns	Second Rate: 80 Guns	Third Rate: [illegible] Guns	Third Rate: 80 Guns	Third Rate: 72 Guns
Guns. 10 inch	87	6 [illegible]												
	84	9 4												
8 inch	65	9 0	16	32	32	12	8	32	24	10	26	4	12	6
	60	8 10												
	52	7 0							2					
68 pounder	95	10 0												
	87	6 6	7	32	24	21	11	81	41	9	26	14	6	22
	16	6 0	6			30				14			36	
	50 45	9 2					12				30			
	45	9 0		2			6					30		
32 pounder	55	9 0	11	14	42	40		41	21	71	6	6	6	32
	42	6												
	32	6												
	40	6 6					30							
	32	6 0	16	11	10									
	25	5 4												
18 pounder	38	6 [illegible]												
	15	5 6												
6 pounder Brass	61	5 0	1	1	1	1	1	1		1	1	1		1
Carronades. 8 inch	56	5 2												
42 pounder	[illegible]	5 2				16	12				6	2		17
32 pounder	17	5 0												
Mortars														
Howitzers. 24 pounder	12	5 [illegible]	2	2	2	2	2	2	2	2	2	2	2	2
12 pounder Heavy	9	4 7												
12 pounder Light	[illegible]	3 9½	1	1	2	2	6	2	2	2	2	2	2	2

Mortars: No proportion. Issued only by special order.

Ordnance	Fourth Rate: 60 Guns	Fourth Rate: 50 Guns	Fourth Rate: 50 Guns	Fourth Rate: 50 Guns	Fifth Rate: 46 Guns	Fifth Rate: 36 Guns	Fifth Rate: 44 Guns	Fifth Rate: 42 Guns	Sixth Rate 1st Class: 28 Guns	Sixth Rate 1st Class: 6 Guns	Sixth Rate 1st Class: 24 Guns	Sixth Rate 1st Class: 26 Guns	Sixth Rate 1st Class: 28 Guns	Sixth Rate 2nd Class: 30 Guns	Sixth Rate 2nd Class: 26 Guns	Sixth Rate 2nd Class: 18 Guns	Sixth Rate 2nd Class: 18 Guns	Sixth Rate 2nd Class: 22 Guns
10 inch, 87 cwt											2		2					
10 inch, 84 cwt																		
8 inch, 65 cwt	10	10	12								10							
8 inch, 60 cwt				8	6	4	4		8									
8 inch, 52 cwt								4		2		2	6			2	2	
68 pounder, 95 cwt																		
68 pounder, 87 cwt	2	2	20		6	12					8							
68 pounder, 16 cwt						2							6					
68 pounder, 50 45 cwt				32														
45 cwt	20	20	6	8			4	4						2		2		
32 pounder, 55 cwt					16					2		22					16	
32 pounder, 42 cwt							24		10	15						11		
32 pounder, 32 cwt								24							2			2
32 pounder, 40 cwt																		
32 pounder, 32 cwt (6 0)	2			6		12			6	6	1		2	6	22			
32 pounder, 25 cwt																		
18 pounder, 38 cwt																		
18 pounder, 15 cwt																		
6 pounder Brass			1	1	1	1	1	1			1	1	1					
Carronades, 8 inch														2				
Carronades, 42 pounder							12	10						6	4			20
Carronades, 32 pounder																		
Howitzers, 24 pounder	2	2	2	2	2	2		2										
Howitzers, 12 pounder Heavy	2	2	2	2	2	2	2	2										
Howitzers, 12 pounder Light	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Ordnance	Sloops: 18 Guns	Sloops: 16 Guns	Sloops: 14 Guns	Sloops: 12 Guns	Sloops: 12 Guns	Sloops: 8 Guns	Sloops: 8 Guns	Brigs: 6 Guns	Brigs: 8 Guns
10 inch, 84 cwt								10	
32 pounder, 32 cwt	2	2	2	2					
32 pounder, 32 cwt (6 0)	6	12	12	16	16	6	8	2	2
Carronades, 42 pounder							6	4	
Howitzers, 12 pounder Light	1	1	1	1	1	1	1	1	1

No. of people required to work the Guns, &c.

Men	Boys or Powder Men
17	1
14	1
12	1
12	1
16	1
13	1
13	1
13	1
11	1
10	1
9	1
8	1
7	1
6	1
5	1
7	1
5	1
6	1
4	1
2	1

* Armament for Quarter deck and Forecastle not settled. † Boat Guns.

‡ 32 pounder, cwt 19, ft 2, in 6. To be introduced gradually into the Naval Service in lieu of the 32 pounder 16 cwt guns.

"The guns proposed are,

"First The present 32 pounders; weight 57 cwt., charge 10 lbs	When mounted on lower decks of line of battle ships
"Secondly. Modified* 32 pounders; weight 42 cwt. (equal to present 18 pounder), charge 5 or 6 lbs	Main decks and in frigates, and hollow shot when close, or charge equal to 1 round grape and 1 round shot
"Thirdly. Second class modified* 32 pounders, weight 25 cwt., charge 3½ or 4 lbs	Quarter decks, forecastle of frigates and line-of battle ships, decks of 18 gun brigs and all smaller vessels"

It may be assumed, therefore, that the principle laid down in the foregoing Memorandum has been happily adopted, by referring to Table I.; and thus the confusion incident to guns of several calibres being placed in one vessel avoided, and the power of the armament greatly increased.

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See 'Artillery' Tables A B C D. The Tables to the article 'Artillery' will give the weights and dimensions of the several pieces of ordnance now used in the armament of ships of war. Table II. of this article gives their ranges. It has been explained in 'Artillery' that the Ordnance Department supply all artillery stores, ammunition, and guns to the Navy, and hence the advantage to the Service generally for a perfect knowledge of the description and nature of these articles.

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* [illegible] different decks in the same vessel, has been in [illegible] others by the [illegible] A.—Editors.

TABLE I

Proportion of Ordnance to be issued to Her Majesty's Ships

ORDNANCE	Weight	Length	First-Rate Classes: 120 Guns	120 Guns	116 Guns	120 Guns (Old Class)*	Second Rate Classes: 104 Guns (Old Class)	90 Guns	90 Guns Old Class	80 Guns	84 Guns Old Class	Third Rate Classes: 8 Guns	0 Guns	72 Guns
Guns	Cwts.	ft in												
12 inch	87	9 4												
	84	9 4												
8 inch	65	9 2	32	32	30	12	6	33	24	14	12	2	12	6
	60	8 10												
	52	8 0							5					
68 pounder ‡	95	12 0												
32 pounder	56	9 6	34	32	30	24	24	31	42	12	21	24	16	22
	50	9 0	6			30				24			28	
	50 48	9 0					18				22			
	45	8 6		2			6					34		
	42	8 0	34	34	40	40		24	32	24	6	6	16	32
	41	7 6												
	40	7 6												
	32	6 6					30							
	25	6 0	14	14	16									
	23	5 4												
18 pounder	20	6 0												
	15	5 6												
6 pounder Brass	6¼†	5 0	1	1	1	1	1	1	1	1	1	1	1	1
Carronades														
8 inch	36	5 4												
32 pounder	17	4 0				14	10				16	12		12
12 pounder	10	2 4												
Mortars			No proportion											
Howitzers														
24 pounder	13†	4 8½	2	2	2	2	2	2	2	2	2	2	2	2
12 pounder Heavy	10†	4 7												
12 pounder Light	6½†	3 9½	2	2	2	2	2	2	2	2	2	2	2	2

ORDNANCE	Weight	Fourth Rate Classes: 60 Guns	50 Guns	60 Guns	50 Guns Old Class	Fifth Rate Classes: 40 Guns	36 Guns	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
8 inch	65	30	18	12															
	60				8	6	4												
32 pounder	56	2	2	20		10	12												
	50						2												
	50 48				22														
	45	20	20	12	4														
	42					16													
	25	2			16		12												
6 pounder Brass	6¼†	1	1	1	1	1	1												
Mortars						Issued only by special order													
12 pounder Heavy	10†	2	2	2	2	2	2	2	2										
12 pounder Light	6½†	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

ORDNANCE	Weight	Sloops Classes: 18 Guns	16 Guns	14 Guns	12 Guns	12 Guns	8 Guns	8 Guns	8 Guns	Steamers	Brigs Classes: 6 Guns	3 Guns	No of people required to work the Guns &c: Men	Boys as Powder Men
12 inch	87 84									The Armaments of Steam Sh ps d ffer much and are very uncertain 10 inch Guns and 68 Pounders of 95 cwt are now used n all the larger vessels the number n table to the capabil ty of the sh p			17	1
8 inch	65												14	1
	60												13	1
	52												12	1
68 pounder ‡	95												18	1
32 pounder	56												13	1
	50												12	1
	50 48												12	1
	45												11	1
	42 41 40	2	2	2	2							1	10	1
	32					2	2	2			2	2	9	1
	25 23	10	14	12	10	10	6						8	1
18 pounder	20								2				7	1
	15								6				6	1
6 pounder Brass	6¼†												3	1
32 pounder (Carronade)	17							6					7	1
12 pounder (Carronade)	10										4		3	1
24 pounder (Howitzer)	13†												6	1
12 pounder Heavy	10†												4	1
12 pounder Light	6½†	1	1	1	1	1	1	1	1		1	1	3	1

* Armament for Quarter deck and Forecastle not settled

† Boat Guns

‡ 32 pounder cwt ft in { 58 { 9 6 } To be introduced gradually into the Naval Service in lieu of the 32 pounder 56 cwt guns

TABLE IV.—*continued*

SPARE ARTICLES	RATES: First	Second	Third	Fourth	Fifth	Sixth	Sloops and Bombs 16 guns and upwards	Steamer Sloops	Brigs under 16 guns	Schooners Cutters &c	Packets, 4 guns and upwards	Steamers under 4 guns
Forelock, keys, iron	Six to each spare axletree											
Forelock, keys, metal	One to each carriage, for all guns											
Handspikes, with rollers	Three for two pivot carriages with Gordon's rollers, and two to each carriage when not so fitted											
Handspikes, 7 feet, common	Four to each carriage for pivot guns of 52 cwt and upwards											
Linchpins, iron, common	Two to each spare axletree, one for each field carriage											
Plugs, for sockets	The number of plugs and sockets cannot be correctly stated, the number varying according to the construction of the ship and fittings of the deck											
Screws, jamming, carronade; gun	One to every eight (or less number of) carriages fitted with Hardy's slides *											
Sockets, metal	The number of sockets cannot be correctly stated, the number varying according to the construction of the ship and fittings of the deck											
Trucks for carriages, common, fore; hind	One of each to every eight (or less number of) common carriages.											
Trucks for carriages, elevating, &c., bottom	One 12 pounder (fore) and one 6 pounder (fore) to each ship											
Washers, iron	One for each field carriage											

* This description includes 32 pounders of 25 cwt and 18-pounder guns according to the new proportions

TABLE V.—*Ammunition for Ship Ordnance*

AMMUNITION FOR SHIP ORDNANCE					Rates: First	Second	Third	Fourth	Fifth	Sixth	Ships and Bombs, 16 guns and upwards	Steamer Sloops	Brigs under 16 guns	Schooners, Cutters, &c	Packets, 4 guns and upwards	Steamers under 4 guns	Charges: Distant	Full	Reduced	
Bearers for shot					Two to each gun of 10 inch and 68 pounders															
Blue lights					24	24	24	24	24	24	16	16	16	16	16	16				To flag ships and broad pennants (Commodores) twelve additional allowed
Cartridges, flannel	filled with powder	ship's establishment	carronade	Pivot														180		
				Side														80		
			gun	Pivot: 10 inch														180		
				Pivot: 68 pounder													120	60		
				Pivot: 8 inch, 65 and 60 cwt													120		60	
				Pivot: 8 inch, 52 cwt														120	60	
				Pivot: 32 pounder 56 cwt													80	60	40	
				Pivot: All other 32 pounders and 18 pounders 22 and 20 cwt														120	60	
				Pivot: 18 pounder 15 cwt															180	
				Side: 10 inch														100		
				Side: 8 inch, 65 or 60 cwt													60	[illegible]	20	
				Side: 8 inch, 52 cwt														60	20	
				Side: 32 pounder 56 cwt													50	10	20	
				Side: All other 32 pounders and 18 pounders 22 and 20 cwt														60	20	
				Side: 18 pounder 15 cwt															80	
		service in boats	howitzers each		438	318	318	321	321	318	201	*	201	201	201	201				
			gun of pounder 1½ lb each		66	66	66	66	66	steel 66										
		short practice	4 oz. each		1020	1020	810	20	360	120		120								
	empty	ship's establishment	carronade		Twenty to each carronade full charge															
			gun		Thirty to each gun above 32 pounders 56 cwt except 8 inch in proportions of													15	15	To guns *not* allowed distant charges
																	7½	7½	15	To guns allowed distant and reduced charges
					Twenty to each gun (8 inch and under 32 pounders 56 cwt) in proportions of												5	10	5	
																		10	10	To guns *not* allowed distant charges except 8 inch 52 cwt which have 15 for full and 5 for reduced charges.
																		20	"	To guns *not* allowed distant or reduced charges
			carronades		Twenty to each													20		

Memorandum.—If a ship cannot stow the whole of her Stores here regulated the Captain is to apply to the Admiralty who will communicate with the Board of Ordnance thereon.

* One to each shot and shell, according to armament

TABLE V.—*continued*

Ammunition for ship ordnance		Rates: First	Second	Third	Fourth	Fifth	Sixth	Sloops and Bombs 16 guns and upwards	Steamer Sloops	Brigs under 16 guns	Schooners, Cutters, &c.	Packets, 4 guns and upwards	Steamers under 4 guns	
Powder, in flannel bags, containing 15 lbs. each, for ship's establishment		Twenty rounds for each gun (excepting pivot guns, which have 30), of full charge for carronades and 8-inch guns, and of the reduced charge for all other guns												
Portfires, for firing rockets, &c.		14	14	11	14	14	14	10	10	10	10	10	10	To flag ships and broad pennants (Commodores), double supply allowed
Portfire sticks		2	2	2	2	2	"	"	"	"	"	"	"	
Rockets, with sticks,	Congreve's, 24-pounder	60	60	60	60	60	60	"	"	"	"	"	"	Not issued, except by express order — Vide Admiralty Regulation
	12 "	"	"	"	"	"	"	36	36	36	36	36	36	
	signal, 1 lb. "	6	6	6	6	6	6	3	3	3	3	3	3	To flag ships and broad pennants (Commodores), double supply allowed
	½ lb. "	18	18	18	18	18	18	9	9	9	9	9	9	
Machines or tubes, for firing rockets,	Congreve's	Two to each ship, when the rockets are supplied.												
	signal, with detonating hammer	One to each ship												

Shells filled with powder, and fixed to wood bottoms.	Number per gun or carronade: Sailing vessels	Steamers	Sailing vessels and screw steamers		
All bow and stern pivot guns	60	60			
10-inch side guns	40	40			
8 inch side guns and carronades, 1st six	10	40			
8 inch side guns and carronades, 2nd six	20	20			
8 inch side guns and carronades, Remaining number	10	10			
32 pounder side guns and carronades in paddle steamers	–	10			
For two 32 pounder guns in sloops and brigs not having guns of a higher calibre	30	–			
Ditto in frigates	40	–			

Memorandum.—When vessels cannot stow their full proportion of filled, empty ones are to be supplied to make up the number allowed, without boxes, but with the proper proportion of fuzes and quantity of powder [illegible] ling them

When the store of Moorsom's fuzes will admit of an extensive supply, the fuzes will be issued in the following proportions:*						Memorandum.—The number of 8-inch shells for any steamer is not to exceed 500.
Fuzes.						
Moorsom's	3 to 4 shells					
3 inch	1 to 4 shells					
4 inch spare	1 to every 2 shells with 3 inch fuzes in steamers and for pivot guns of sailing vessels. One to every 3 shells with 3 inch fuzes for all other guns of sailing vessels.					
			With short range fuzes	With Moorsom's fuzes	With 3 inch fuzes	
Shells filled with powder. Are in addition to the above: 1st rates	-	-	150	150	150	
2nd rates, Princess Charlotte class	-	-	1 0	130	130	
Other 2nd rates	-	-	100	100	100	
3rd rates	-	-	100	100	100	Memorandum.—Vessels commanded by Officers below a Commander are not to have shells with Moorsom's fuzes.
4th rates	-	-	60	60	60	
5th rates	-	-	50	50	50	
6th rates		-	35	35	35	Memorandum.—If any ship carrying carronades can conveniently stow a greater proportion of round shot, an additional number will be supplied on application to the Ordnance Storekeeper at the Port.
All sloops	-	-	25	25	25	
Shot: All bow and stern pivot guns	120	120				
10 inch solid guns	60	60				
8 inch shell guns and carronades: 1st six	40	40				
2nd six	60	60				Shells not being allowed to carronades and guns of a lower calibre than 32-pounders, these descriptions of ordnance will be supplied with an additional number of shot equal to the number of shells above given.
Remaining number	70	70				
32-pounder solid guns and carronades	80	0				
All other solid guns and carronades below 32-pounders	80	80				

* In the meantime the issues are made as follows:—Moorsom's 3 to 4 shells; 3 inch 3 to 4 shells; except for 32-pounders as given in the three last columns.

TABLE VII.—*Packages*

Packages	Rates: First	Second	Third	Fourth	Fifth	Sixth	Sloops and Bombs, 18 guns and upwards	Steamer sloops	Brigs under 16 guns	Schooners, Cutters, &c.	Packets, 4 guns and upwards	Steamers under 4 guns	
Bags, flannel, to hold 15 lbs. of powder	Sufficient for the powder (not filled into cartridges) for guns, carronades, and small arms												
Baskets, for covering bottles of glass, stone	One to each.												
Bottles, glass, stone, tin	Sufficient for the oil, &c												
Boxes for lead ball, or shot, musket, pistol; shot, guns, grape, tin case; shot, carronades, grape in tin cases, tin case; shells and 32 [illegible]	Sufficient for the shot and shells of each description												
Casks, or kegs	Sufficient for the whiting, &c												
Cases, lined with metal, whole, half, quarter	Sufficient to contain the filled cartridges for the guns and carronades, and for muskets and pistols; also for the whole of the powder in flannel bags for guns, carronades, and small arms. N.B.—Signal rockets are packed in half cases.												Deal or metal cases are to be used for steamers instead of metal lined.
Cases, packing, of sorts	Sufficient to contain the empty cartridges, and laboratory small stores, &c.; also for Congreve's rockets when embarked												

Note.—Tables IV, V, VI, and VII of Equipment, Naval, are now in course of re-arrangement, and will, when sanctioned by authority, be inserted.

EQUIPMENT, AMERICAN,* for Trains of Artillery,—Armament of Fortifications,—Field Train,—as prescribed by the Secretary at War of the United States

FIELD TRAIN

Ordnance

The proportion of artillery to other troops varies generally between the limits of 1 and 3 pieces to 1000 men, according to the force of the army, the character of the troops of which it is composed, the force and character of the enemy, the nature of the country which is to be the theatre of war, and the character and objects of the war

Similar considerations must regulate the selection of the kinds of ordnance, and the proportions of the different kinds in the train

The following principles may be observed in ordinary cases

2 pieces to 1000 men { ¾ guns, of which { ⅓ are 12 pounders, ⅔ are 6 pounders; ¼ howitzers of which { ⅓ are 24 pounders, ⅔ are 12 pounders,

distributed as follows

For the Infantry 1 piece to 1000 men,—6 pounder guns and 12 pounder howitzers, in batteries of foot artillery

For the Cavalry 2 pieces to 1000 men,—6 pounder guns and 12 pounder howitzers, in batteries of horse artillery

For the Special and General Parks of Reserve

1 piece to 1000 men { ½ in 12 pounder batteries of foot artillery, ¼ in 6 pounder ditto ditto, ¼ in 6 pounder batteries of horse artillery

Ammunition for Cannon

Two hundred rounds to each piece, both of the reserves and of the active batteries

The ammunition which cannot be carried in the caissons attached to the pieces will be kept in boxes with the reserves

Proportion of the different kinds of Ammunition and other Supplies

Kind	For Guns		For Howitzers		
	12 prs	6 prs	24 prs	12 prs	
Strapped shot fixed	76	70	–	–	For 100 rounds
Canisters, fixed	12	20	–	–	
Strapped shells	–	–	52	48	
Spherical case-shot, strapped	12	10	35	40	
Canisters with sabots	–	–	13	12	
Cartridges { large charge (spare)	6	4	8	6	
Cartridges { small charge	12	10	100	100	
Fuzes	Twice the number of shells and spherical case shot				
Portfires	1 to 5 rounds				
Tubes	¼ more than the number of rounds				
Slow match	1 yard to 5 rounds				
Quick match	¼ yard to each spherical case shot				
Bursters	1 to each shell and spherical case shot				

* Ordnance Manual published by authority of the American Government

Additional supplies of ordnance and ordnance stores are placed in convenient depôts according to circumstances

Ammunition for Small Arms

One hundred rounds to each man of which for the musket 40 rounds are in the cartridge box, 60 in the parks of reserve. In the same proportion for other small arms

Five flints to 100 rounds

Percussion caps for carbines half more than the number of cartridges

Composition of a Battery on the War Establishment

	Kind of Battery	12 pr	6-pr
Guns	12 pounders mounted	4	–
	6 pounders do	–	4
Howitzers	24 pounders do	2	–
	12 *pounders do*	–	2
	Total number of pieces mounted	6	6
Carriages	Gun carriages (spare)	1	1
	Caissons	12	6
	Forges (1 for repairs and 1 for shoeing)	2	2
	Battery waggons (1 for repairs 1 for harness)	2	2
	Total number of carriages	17	11

Implements and Equipments for each Gun Carriage

2 Gunner's haversacks	1 Vent punch
1 Tube pouch	1 Gunner's gimlet
1 Portfire case	1 Tangent scale
2 Thumbstalls	1 pair Portfire cutters
1 Priming horn	2 Sponges and rammers
1 Prolonge	2 Sponge covers
1 *Vent-cover and strap.*	½ Worm and Staff
1 Lintstock	2 Handspikes
1 Portfire stock	1 Sponge bucket
1 Priming wire	1 Tow hook
1 Fuze auger	1 Fuze rasp
1 Fuze saw	1 Fuze mallet.
1 Fuze sett	1 Shell plug screw

For each Howitzer Carriage (additional)

1 Fuze extractor	1 Gunner's quadrant
1 Copper funnel	1 8 oz Powder measure

For each Caisson

1 Felling axe.	1 Spare wheel to each caisson of the reserves
1 Shovel.	1 Spare handspike
1 Pick	1 Tar bucket
1 Spare pole (one half of them ironed)	3 Tow hooks

For each Forge

1 Water bucket	1 Shovel

Draught Horses—6 to a battery waggon and 12 pounder gun carriage—4 to other carriages—$\frac{1}{12}$th spare

Harness—corresponding with the number of horses to the carriages

The equipments required for the immediate service of a piece are carried, on the march, in the ammunition chest of the limber

SIEGE TRAIN

The number and kind of cannon for a siege train must be determined by the circumstances of each case but the following general principles may be observed in assigning the proportion of different kinds and calibres, and the relative quantity of other supplies, for a train of 100 pieces of ordnance

Cannon

Guns	24 pounder, about	one third of the whole number	32	100
	18 pounder,	one tenth	,	10	
	12 pounder, ,	one tenth	,	10	
Howitzers	8 inch siege, ,,	one-eighth	,,	13	
Mortars	10 inch siege ,,	one seventh	,	14	
	8 inch siege, ,	one fourteenth	,,	7	
Stone mortars	,	one seventh	,	14	
Coehorn mortars (in addition to the 100 pieces)				6	
Wall pieces, for the attack of one front				40	

Gun Carriages

For 24 pounder guns and 8 inch howitzers	one third spare	60
For 18 pounder and 12 pounder guns	one fourth spare	25
For 10 inch mortars and stone mortars,	one third spare	38
For 8 inch mortars and stone mortars,	one fourth spare	9

Other Carriages

Transporting carriages for mortars—1 for each 10 inch mortar and bed, for each stone mortar and bed, and for three 8 inch mortars and beds	33
Waggons, for transporting implements, &c, intrenching and miners tools, laboratory tools and utensils and other stores—each loaded with about 2700 lbs, say	140
Trench carts (carrying balls, &c., on the march)	50
Battery waggons 1 to 100 horses	28
Forges, fully equipped	8
Sling carts	5

Draught Horses

For each 24 pounder and 18 pounder gun and 8 inch howitzer with its carriage	8
,, 12 pounder gun with its carriage	6
,, spare gun carriage and forge	4
,, transporting carriage for mortars	8
,, park and battery waggon	6
,, trench cart	2
,, sling cart	2
Spare horses	$\frac{1}{10}$th
Total say	1800

Projectiles and Ammunition

For guns	Round shot	1000 to each 24 pounder	32 000
		1000 to each 18 pounder	10 000
		1200 to each 12 pounder	12 000
	Grape and canister, 50 rounds to each piece		2,600
	Spherical case, 100 rounds to each piece		5,200
For howitzers	Shells . . 800 to each 8 inch		10 400
	Canisters . 50 do.		650
	Spherical case 100 do.		1,300
For mortars	600 shells to each 10 inch		8 400
	800 " 8 inch		5 600
	600 " Coehorn		3 600

Gunpowder, in barrels . . . . lbs 500,000

Computing for each round shot, ¼th the weight of shot

" grape, canister, and spherical case, ¼th the weight of shot.

"	round of howitzer ammunition,		3 lbs	including charge of shells.
"	"	10 inch mortar	7	including charge of shells.
"	"	8-inch do.	3	including charge of shells.
"	"	Coehorn	½ lb.	
"	"	stone mortar	1	

Paper cartridge-bags, 400 to each piece	40 000
Cartridge-paper, bundles	200
Sabots, 200 to each gun and howitzer	13 000
Slow-match	lbs. 4,500
Portfires	8 000
Priming tubes	80,000
Fuzes, ¼th more than the number of shells	40 000
Wooden bottoms and *baskets* for stone mortars, 800 to each	11,200

Percussion primers, for pieces furnished with locks, ½ to spare

Cartridges for wall-pieces, 500 rounds to each

Cartridges, powder, flints, and *lead*, for small arms, according to the force of the army.

Most of the ammunition is transported by hired waggons.

Implements and Equipments For each Gun

3 Sponges—2 spare
2 Rammers—1 spare
½ Worms.
½ Ladles
8 Handspikes—2 spare.
2 Lintstocks—1 spare
1 Portfire stock.
1 Pass box.
1 Tube pouch.
1 Priming horn.
2 Thumbstalls.
2 Priming wires—1 spare.
1 Gunner's gimlet.
1 Tangent scale
2 Mauls
1 Vent-cover
1 Sponge bucket
1 Broom
1 Percussion lock.

For each Howitzer and Mortar

Implements	Howitzer	Mortar
Sponges and Rammers	3—2 spare	2—1 spare
Ladles	½	
Handspikes (2 shod, for mortar)	6—2 spare	6—2 spare

Implements.	Howitzer	Mortar
Lintstocks	2—1 spare	2—1 spare
Portfire stocks	1	1
Haversacks	1	1
Priming wires	2—1 spare	2—1 spare
Gunners gimlets	1	1
Quadrants	1	1
Mauls	2	2
Fuze drifts	2—1 spare	* 2—1 spare
Mallets	2—1 spare	* 2—1 spare
Baskets	1	1
Tampeons	1	1
Sponge bucket	1	1
Broom	1	1
Percussion locks	1	-
Plummet	-	1
Pointing wires	-	* 2
Quoins	-	2
Shell hooks	-	* 2—1 spare
Scrapers	-	1
Spatulas	-	* 1
Gunner's sleeves (pair)	-	1
Sand bags to wipe with	-	1

Scales and weights funnel set of powder measures of three sizes shell plug screw and fuze extractor to each battery magazine

Implements marked * are not required for the stone mortar the number of implements must be proportioned to the whole number of gun carriages including the spare carriages.

Platforms

For guns and howitzers	one tenth spare	72
For mortars	one-eighth spare	40

Embrasure Shutters

Half the number of guns and howitzers	33

Spare parts of carriages &c (*See Armament of Fortifications* p 481)
Spare parts of field carriages as for field batteries.

Timber and other Materials for Repairs

Proportion to the number of parts that enter into the construction of the carriages

Axle bodies for siege carriages $\frac{1}{20}$th—breech bolsters $\frac{1}{20}$th—cheeks $\frac{1}{20}$th—felloes $\frac{1}{20}$th—spokes $\frac{1}{20}$th—fork saddles $\frac{1}{20}$th—poles $\frac{1}{20}$th—hounds $\frac{1}{20}$th—splinter bars $\frac{1}{20}$th—double trees $\frac{1}{10}$th—square timber of various scantling—plank—wooden part of transporting carriages of each $\frac{1}{20}$th

Bar iron assorted 80 lbs. to a piece 8000 lbs.—steel 5 lbs. to a piece 500 lbs.—sheet iron 50 sheets—iron wire 400 lbs —sheet tin 100 sheets—nails and screws assorted

Projectiles and Ammunition.

For guns	Round shot	1000 to each 24 pounder	32 000
		1000 to each 18 pounder	10 000
		1200 to each 12 pounder	12 000
	Grape and canister 50 rounds to each piece		2 600
	Spherical case 100 rounds to each piece		5 200
For howitzers	Shells	800 to each 8 inch	10 400
	Canisters	50 do	650
	Spherical case	100 do	1 300
For mortars	600 shells to each 10 inch		8 400
	800	8 inch	5 600
	600	Coehorn	3 600
Gunpowder, in barrels			lbs 500 000

Computing for each round shot ¼th the weight of shot

"	grape, canister and spherical case, ⅛th the weight of shot		
"	round of howitzer ammunition	5 lbs	including charge of shells
"	10 inch mortar	7	
"	8 inch do	3	
"	Coehorn	½ lb	
"	" stone mortar	1	

Paper cartridge bags 400 to each piece	40 000
Cartridge paper, bundles	200
Sabots 200 to each gun and howitzer	13 000
Slow match	lbs 4 500
Portfires	8 000
Priming tubes	80 000
Fuzes ¼th more than the number of shells	40 000
Wooden bottoms and *baskets* for stone mortars 800 to each	11,200

Percussion primers for pieces furnished with locks ½ to spare

Cartridges for wall-pieces 500 rounds to each

Cartridges powder flints and *lead* for small arms according to the force of the army

Most of the ammunition is transported by hired waggons

Implements and Equipments For each Gun

- 3 Sponges—2 spare
- 2 Rammers—1 spare
- ½ Worms
- ½ Ladles
- 8 Handspikes—2 spare
- 2 Lintstocks—1 spare
- 1 Portfire stock.
- 1 Pass box.
- 1 Tube pouch.
- 1 Priming horn
- 2 Thumbstalls
- 2 Priming wires—1 spare
- 1 Gunner's gimlet
- 1 Tangent scale
- 2 Mauls
- 1 Vent cover
- 1 Sponge bucket
- 1 Broom
- 1 Percussion lock

For each Howitzer and Mortar

Implements	Howitzer	Mortar
Sponges and Rammers	3—2 spare	2—1 spare
Ladles	½	
Handspikes (2 shod for mortar)	6—2 spare	6—2 spare

Implements.	How tzer	Mortar
Linstocks	2—1 spare	2—1 spare
Portfire stocks	1	1
Haversacks	1	1
Priming wires	2—1 spare	2—1 spare
Gunners' gimlets	1	1
Quadrants	1	1
Mauls	2	2
Fuze drifts	2—1 spare	* 2—1 spare
Mallets	2—1 spare	* 2—1 spare
Baskets	1	1
Tampeons	1	1
Sponge bucket	1	1
Broom	1	1
Percussion locks	1	-
Plummet	-	1
Pointing wires	-	* 2
Quoins	-	2
Shell-hooks	-	* 2—1 spare
Scrapers	-	1
Spatulas	-	* 1
Gunner's sleeves (pair)	-	1
Sand-bags to wipe with	-	1

Scales and weights funnel, set of powder measures of three sizes shell plug screw and fuze extractor to each battery magazine

Implements marked * are not required for the stone mortar the number of implements must be proportioned to the whole number of gun carriages including the spare carriages.

Platforms

For guns and howitzers	one tenth spare	72
For mortars	one-eighth spare	40

Embrasure Shutters

Half the number of guns and howitzers	33

Spare parts of carriages &c (See *Armament of Fortifications* p 481)
Spare parts of field carriages as for field batteries.

Timber and other Materials for Repairs

Proportion to the number of parts that enter into the construction of the carriages

Axle bodies for siege carriages 1/20th—breech bolsters 1/20th—cheeks 1/10th—felloes 1/30th—spokes 1/20th—fork saddles 1/10th—poles 1/20th—rounds 1/20th—splinter bars 1/20th—double trees 1/10th—square timber of various scantling—plank—wooden part of transporting carriages of each 1/20th

Bar iron assorted 60 lbs to a piece 6000 lbs—steel 5 lbs to a piece 500 lbs—sheet iron 50 sheets—iron wire 400 lbs—sheet tin 100 sheets—nails and screws assorted

Small Arms

Muskets	$\frac{1}{3}$	More than the number of troops of the several kinds supposed to be fully armed and equipped
Musketoons . .	$\frac{1}{3}$	
Pistols . . .	$\frac{1}{4}$	
Artillery and Infantry swords .	$\frac{1}{25}$	
Cavalry sabres .	$\frac{1}{5}$	

Wall pieces, 50 to a front of attack, or a front exposed to escalade.

Ammunition —*Musket cartridges for each man*		400
	Musketoon pistol, and rifle cartridges	100
	Cartridges for each wall piece	400

Spare powder for small arms, $\frac{1}{25}$th of the whole quantity required for the cartridges, cartridge paper in proportion

Flints, 1 to 10 rounds, percussion caps, $1\frac{1}{4}$ to a round, for arms with percussion locks.

Implements and Equipments for each Gun

2 Rammers—1 spare	1 Priming horn
2 Sponges—1 spare.	2 Thumbstalls—1 spare
½ Worms	2 Priming wires—1 spare
½ Ladles.	1 Gunner's gimlet
2 Lintstocks—1 spare	1 Hausse, or tangent scale
1 Portfire stock	1 Vent-cover, or lock-cover
1 Pass box	1 Percussion lock
2 Budge barrels.	1 Water bucket
1 Tube pouch	

For each Howitzer

The same as for a gun, omitting *Pass box*, and adding—

1 Haversack	1 Quadrant
2 Fuze setters	1 Fuze saw
2 Fuze mallets	1 Fuze gimlet
1 Fuze extractor to 6 pieces	

For each Mortar

2 Sponges and rammers	2 Shell hooks
6 Handspikes—4 shod	1 Scraper
2 Lintstocks	1 Spatula
1 Haversack.	1 pair Gunner's sleeves
1 Tube pouch.	1 Sand bag
2 Priming wires	2 Fuze setters } 1 spare
1 Gunner's gimlet	2 Mallets } 1 spare
1 Quadrant	2 Fuze saws } 1 spare
1 Plummet	½ Fuze extractors.
2 Pointing wires.	1 Baske[illegible]
2 Quoins.	1 Br[illegible]
1 Tampeon	1 Ta[illegible]

The implements for [illegible] ired for the s[illegible]

For each Casemate C[illegible] the Spare C[illegible] versing hand-

spikes—2 truck handsp[illegible] evating n[illegible] *s, 2 spare* —

1 broom

For each Barbette Carriage.—4 maneuvering handspikes, 2 spare—1 tarpaulin or other cover—1 platform and 12 mauls (*if the platform is not permanent*).

For each Siege Carriage.—4 handspikes, 2 spare—2 mauls—1 platform.

Spare Parts for Repair of Carriages.

Proportion of the number of spare parts to that of similar parts which belong to the carriages.

Forks for traversing wheels of barbette carriages	[illegible]
Pintles for siege carriage limbers	[illegible]
Pintles for casemate carriages	[illegible]
Linchpins	[illegible]
Axletrees — for siege carriages	[illegible]
Axletrees — for barbette carriages	[illegible]
Axletrees — for casemate carriages	[illegible]
Rollers for casemate carriages	[illegible]
Bolster-plates for pintles not permanently fixed	[illegible]
Wheels — for siege carriages	[illegible]
Wheels — for barbette upper carriages (including rollers)	[illegible]
Wheels — for casemate carriages	[illegible]
Wheels — for barbette chassis	[illegible]
Wheels — for casemate chassis	[illegible]
Axle-washers — shoulder	[illegible]
Axle-washers — linch	[illegible]
Poles for siege carriage limbers, one-half ironed	[illegible]
Elevating screws	[illegible]
Double trees for siege carriages, one-half ironed	[illegible]
[illegible] (iron) for casemate carriages	[illegible]
Nuts, assorted	[illegible]

Timber, and other Materials for Repairs.

Cheeks, stocks, naves, spokes, fellies, for siege carriages, of each [illegible]—cheeks of mortar-beds, [illegible]—handspikes, 4 to a piece—tool-handles, 1/4—sets of timber for barbette carriages, [illegible]—ditto casemate, [illegible]—iron, assorted, 30 lbs. to each piece—nails and screws, assorted, 1 lb. to each piece—steel, 1 lb. to each piece—sheet iron, 6 square feet to each piece—tin, 5 sheets to each piece—spare parts for small arms.

Machines, Ropes, &c.

Gins, casemate and campaign, as may be required, according to the extent of the fort—jack-screws—capstans—lever-jacks—wheel-barrows, 1 to each piece—hand-barrow, for shells, 1 to each mortar—sling hand-barrow and frame hand-barrow with legs, 1 to each gun and howitzer—platform balance, or scales and weights—gin falls, [illegible] spare—double prolonges, 2 to each gun—drag-ropes—trace-ropes—small rope, 5 lbs. to a piece.

Tools.

Sets of carriage-makers', smiths', and armourers' tools—carpenters' and masons' tools—saws—levels—gunners' [illegible]—[illegible]—the number of each kind to be regulated by the particular circumstances of each case.

Small Arms.

Muskets	$\frac{1}{3}$	More than the number of troops of the several kinds, supposed to be fully armed and equipped.
Musketoons	$\frac{1}{4}$	
Pistols	$\frac{1}{4}$	
Artillery and Infantry swords .	$\frac{1}{25}$	
Cavalry sabres	$\frac{1}{5}$	

Wall-pieces, 50 to a front of attack, or a front exposed to escalade.

Ammunition.—Musket cartridges for each man . . . 400
Musketoon, pistol, and rifle cartridges . . 100
Cartridges for each wall-piece . . . 400

Spare powder for small arms, $\frac{1}{12}$th of the whole quantity required for the cartridges; cartridge-paper in proportion.

Flints, 1 to 10 rounds; percussion caps, $1\frac{1}{4}$ to a round, for arms with percussion locks.

Implements and Equipments for each Gun.

2 Rammers—1 spare.
2 Sponges—1 spare.
½ Worms.
½ Ladles.
2 Lintstocks—1 spare.
1 Portfire stock.
1 Pass box.
2 Budge barrels.
1 Tube pouch.
1 Priming horn.
2 Thumbstalls—1 spare.
2 Priming wires—1 spare.
1 Gunner's gimlet.
1 Hausse, or tangent scale.
1 Vent-cover, or lock-cover.
1 Percussion lock.
1 Water bucket.

For each Howitzer.

The same as for a gun, omitting *Pass box*, and adding—

1 Haversack.
2 Fuze setters.
2 Fuze mallets.
1 Fuze extractor to 6 pieces.
1 Quadrant.
1 Fuze saw.
1 Fuze gimlet.

For each Mortar.

2 Sponges and rammers.
6 Handspikes—4 shod.
2 Lintstocks.
1 Haversack.
1 Tube pouch.
2 Priming wires.
1 Gunner's gimlet.
1 Quadrant.
1 Plummet.
2 Pointing wires.
2 Quoins.
1 Tampeon.
2 Shell-hooks.
1 Scraper.
1 Spatula.
1 pair Gunner's sleeves.
1 Sand-bag.
2 Fuze setters } 1 spare.
2 Mallets
2 Fuze saws
½ Fuze extractors.
1 Basket.
1 Broom.
1 Tarpaulin.

The implements *for shells* are not required for the stone mortar.

For each Casemate Carriage (including the Spare Carriages)—2 traversing handspikes—2 truck handspikes—1 quoin, or elevating machine—4 chocks, 2 spare—1 broom

For each Barbette Carriage —4 manœuvring handspikes 2 spare—1 tarpaulin or other cover—1 platform and 2 mauls; if the platform is not permanent

For each Siege Carriage —4 handspikes 2 spare—2 mauls—1 platform

Spare Parts for Repair of Carriages

Proportion of the number of spare parts to that of similar parts which belong to the carriages

Forks for traversing wheels of barbette carriages	[illegible]th
Pintles for siege carriage limbers	[illegible]th
Pintles for casemate carriages	[illegible]th
Linchpins	[illegible]th
Axletrees — for siege carriages	[illegible]th
Axletrees — for barbette carriages	[illegible]th
Axletrees — for casemate carriages	[illegible]th
Rollers for casemate carriages	[illegible]th
Bolster plates for pintles not permanently fixed	[illegible]th
Wheels — for siege carriages	[illegible]th
Wheels — for barbette upper carriages (including rollers)	[illegible]th
Wheels — for casemate carriages	[illegible]th
Wheels — for barbette chassis	[illegible]th
Wheels — for casemate chassis	[illegible]th
Axle washers — shoulder	[illegible]th
Axle washers — linch	[illegible]th
Poles for siege carriage limbers one half ironed	[illegible]th
Elevating screws	[illegible]th
Double trees for siege carriages, one half ironed	[illegible]th
Tongues (iron) for casemate carriages	[illegible]th
Nuts assorted	[illegible]th

Timber and other Materials for Repairs

Cheeks stocks naves spokes felloes for siege carriages; of each [illegible]th—cheeks of mortar beds [illegible]th—handspikes 4 to a piece—tool-handles, [illegible]—sets of timber for barbette carriages [illegible]th—ditto casemate [illegible]—iron assorted, [illegible] to each piece—nails and screws assorted 100 to each piece—steel, [illegible] to each piece—sheet iron 6 square feet to each piece—tin 3 sheets to each piece—spare parts for small arms

Machines [illegible]

Gyns casemate and rampart as may be required, according to the extent of the fort—jack-screws—capstans—lever jacks—wheel-barrows 1 to each piece—hand barrow for shells, 1 to each mortar—[illegible] hand barrow and frame hand barrow with legs, 1 to each gun and how[illegible] [illegible] balance or scales and weights [illegible] [illegible] th spare—double prolonges, 2 to each gun—[illegible] ropes—[illegible] ropes—[illegible] rope 5 lbs. to a piece

Tools

Sets of carriage makers [illegible] [illegible] [illegible] [illegible] and [illegible] tools—saws—levels—[illegible] rammers—[illegible] the number of each kind to be required [illegible] the [illegible] of each case

Small Arms.

Muskets	$\frac{1}{4}$	More than the number of troops of the several kinds, supposed to be fully armed and equipped.
Musketoons	$\frac{1}{4}$	
Pistols	$\frac{1}{4}$	
Artillery and Infantry swords	$\frac{1}{10}$	
Cavalry sabres	$\frac{1}{4}$	

Wall pieces, 50 to a front of attack, or a front exposed to escalade.

Ammunition.—Musket cartridges for each man	400
Musketoon, pistol, and rifle cartridges	100
Cartridges for each wall piece	400

Spare powder for small arms, $\frac{1}{25}$th of the whole quantity required for the cartridges; cartridge-paper in proportion

Flints, 1 to 10 rounds; percussion caps, $1\frac{1}{4}$ to a round, for arms with percussion locks.

Implements and Equipments for each Gun

2 Rammers—1 spare.	1 Priming horn.
2 Sponges—1 spare.	2 Thumbstalls—1 spare
$\frac{1}{2}$ Worms	2 Priming wires—1 spare.
$\frac{1}{4}$ Ladles.	1 Gunner's gimlet.
2 Lintstocks—1 spare	1 Hausse, or tangent scale
1 Portfire stock.	1 Vent-cover, or lock-cover.
1 Pass box	1 Percussion lock.
2 Budge barrels.	1 Water bucket.
1 Tube pouch.	

For each Howitzer.

The same as for a gun, omitting *Pass box*, and adding—

1 Haversack.	1 Quadrant
2 Fuze setters.	1 Fuze saw.
2 Fuze mallets.	1 Fuze gimlet.
1 Fuze extractor to 6 pieces.	

For each Mortar.

2 Sponges and rammers.	2 Shell-hooks.	
6 Handspikes—4 shod	1 Scraper.	
2 Lintstocks	1 Spatula	
1 Haversack.	1 pair Gunner's sleeves	
1 Tube pouch.	1 Sand bag	
2 Priming wires	2 Fuze setters	1 spare.
1 Gunner's gimlet	2 Mallets	
1 Quadrant.	2 Fuze saws	
1 Plummet.	$\frac{1}{2}$ Fuze extractors.	
2 Pointing wires.	1 Basket.	
2 Quoins.	1 Broom.	
1 Tampeon.	1 Tarpaulin.	

The implements for *shells* are not required for the stone mortar

For each Casemate Carriage (including the Spare Carriages)—2 traversing handspikes—2 truck handspikes—1 quoin, or elevating machine—4 chocks, 2 spare—1 broom

For each Barbette Carriage.—4 manœuvring handspikes 2 spare—1 tarpaulin or other cover—1 platform and 2 mauls, if the platform is not permanent

For each Siege Carriage.—4 handspikes 2 spare—2 mauls—1 platform

Spare Parts for Repair of Carriages

Proportion of the number of spare parts to that of similar parts which belong to the carriages

Forks for traversing wheels of barbette carriages	$\frac{1}{20}$th
Pintles for siege carriage limbers	$\frac{1}{20}$th
Pintles for casemate carriages	$\frac{1}{10}$th
Linchpins	$\frac{1}{4}$th
Axletrees { for siege carriages	$\frac{1}{20}$th
Axletrees { for barbette carriages	$\frac{1}{10}$th
Axletrees { for casemate carriages	$\frac{1}{20}$th
Rollers for casemate carriages	$\frac{1}{20}$th
Bolster plates for pintles not permanently fixed	$\frac{1}{10}$th
Wheels { for siege carriages	$\frac{1}{12}$th
Wheels { for barbette upper carriages (including rollers)	$\frac{1}{20}$th
Wheels { for casemate carriages	$\frac{1}{20}$th
Wheels { for barbette chassis	$\frac{1}{10}$th
Wheels { for casemate chassis	$\frac{1}{10}$th
Axle washers, { shoulder	$\frac{1}{20}$th
Axle washers, { linch	$\frac{1}{10}$th
Poles for siege carriage limbers one half ironed	$\frac{1}{4}$th
Elevating screws	$\frac{1}{4}$th
Double trees for siege carriages one half ironed	$\frac{1}{4}$th
Tongues (iron) for casemate carriages	$\frac{1}{10}$th
Nuts assorted	$\frac{1}{10}$th

Timber, and other Materials for Repairs

Cheeks stocks naves spokes felloes for siege carriages of each $\frac{1}{8}$th—cheeks of mortar beds $\frac{1}{12}$th—handspikes 4 to a piece—tool handles ½—sets of timber for [illegible]—iron assorted 50 lbs to each piece [illegible]—steel 1 lb to each piece—sheet [illegible] each piece—spare parts for small arms

Machines Ropes &c

Gyns casemate and rampart as may be required, according to the extent of the fort—jack screws—capstans—lever jacks—wheel-barrows 1 to each piece—hand barrow for shells, 1 to each mortar—sling hand barrow and frame hand barrow with legs 1 to each gun and howitzer—platform balance or scales and weights—gyn falls ¼th spare—*double prolonges* 2 to each gun—drag ropes—trace ropes—small rope 5 lbs. to a piece

Tools

Sets of carriage makers smiths and armourers tools—intrenching and mining tools—saws—levels—pavious rammers—10-ft. rods—2-ft. rules The number of each kind to be regulated by the particular circumstances of each case

Tools and Materials for Fire works, &c

Laboratory tools and materials, according to the extent and resources of the fort: see the proportion of those for a siege train For each night of a siege, or for each night on which the guns will probably be served, have six tarred links to each piece, mounted on the ramparts of a front of attack, or of a sea coast battery, and five fire-balls for a front of attack; six carcases for each large mortar on a front of attack.

Signal rockets, torches, fire stone, &c, according to circumstances.

Instruments, Books, Stationery, &c

According to the character and extent of the fort —See 'Siege Train' p 476

Miscellaneous Supplies

Timber, plank, and boards—wood for sabots, fascines, gabions, &c.—pickets—coal, 5 tons to a forge—grease—grind stones—rampart grates, 2 to each piece on the ramparts—sand bags for the batteries of the front of attack—lanthorn, 1 to each piece—candles—oil—fire-engine and buckets

Field pieces, forming a part of the armament of a fortification, should be provided with their caissons, ammunition, &c, as for service in the field

EQUIPMENT, MUSKET-BALL CARTRIDGE.

Musket Ball Cartridge Equipment is important to every branch of the army as regards an adequate supply and mode of conveyance The several descriptions of musket ball cartridge, and the mode of packing as adopted in the Laboratory at Woolwich, is explained in the article 'Ammunition'

In order to regulate the supply and mode of conveyance, and describe the equipment, it is necessary to give the proportion required for an army taking the field The Committee of Artillery Officers at Woolwich recommended that it should not be less than five times the quantity carried by the soldier, *i e* supposing the army to be sixty *thousand, 60,000 × 60 × 5 = 18,000,000 ball cartridges necessary for six months'* active operations This quantity could be only supplied in certain proportions, accord-

car by four horses; the wheels and axles are similar to the Ammunition Waggon, and it seems well adapted for the conveyance of musket ball cartridges in any country where a field battery can move

... ed by organizing a certain

* For the waggon of this equipment as now adapted to the Service see article 'Carriage

Table of Musket-Ball Cartridge Equipments.

Nature	Cavalry Division for 80 000 rounds	Infantry Divisi n for 240 000 rounds	Reserve for three Divis ons carrying 400 000 rounds.	Remarks
Waggons				
Musket-ball	4	12	20	See Plate
Forge	1	1	1	*Ordinary forge waggon*
Store	1	2	3	Flanders waggon
Total waggons .	6	15	24	
Royal Artillery				
Captain	–	1	1	
Lieutenants	1	2	3	
Surgeon	–	1	1	
Staff Serjeant . . .	–	1	1	
Serjeants	1	2	3	
Corporals	1	2	3	
Bombardiers . . .	2	4	6	
Buglers	1	2	2	
Gunners	18	36	54	
Drivers	12	30	48	
Farriers	–	1	1	
Shoeing Smiths . .	1	2	3	
Total	37	84	126	
Horses				
Draught	24	60	96	
Saddle	3	6	9	
Baggage	1	4	5	
Total horses . .	28	70	110	

For an army of 60,000 men, there will be consequently

$$\left.\begin{array}{l}\text{Two Cavalry equipments}\\ \text{Six Infantry} \quad ,,\\ \text{Two Reserve} \quad ,,\end{array}\right\}\text{150 waggons,*}$$

conveying 2,680,000 ball cartridges, or about ⅛th of the proportion allotted to this *army at the commencement of a campaign. As this supply is expended, the equipments* will return to the entrepôt to be replenished.

The supply for a siege operation is afforded usually by taking the waggons of the country for this purpose

The Artillery Department has the organization and charge of the musket-ball cartridge equipments to an army moving in the field, but the responsibility of the proportions to be supplied should be with the Adjutant-General's Department, which alone is acquainted with the expenditure and wants of the army this has hitherto been thrown on the Artillery It would appear to suffice, if these last kept the equipments efficient, and the requisite supply at the entrepôts, leaving the extent of that supply to be determined by the proper Department.

A musket ball *equipment*, composed of two-wheeled carts, and drawn by two horses, has been used, and this equipment supplied the British army at Waterloo

* Including forge and store waggons as above detailed.

it was used in Ireland in 1815, and seems only adapted to limited operations, in advance

The comparative utility of two and four-wheeled waggons has been well compared and discussed and apparently finally settled in favour of the latter by the Committee of Artillery Officers, whose opinions are too valuable, on this and all other equipments, to be passed over, and are given in the following extract:

"*Conveyance of Small-Arm Ammunition*.—The usual means of conveying small-arm ammunition in the British Service has hitherto been the musket ball cartridge cart holding 12 000 rounds drawn by two horses during the Waterloo campaign however, only 10 000 rounds were carried in the cart, as that quantity was deemed a sufficient load, but this, in common slow movements even, was found too much for a pair of horses, far less could they be expected therefore to move at an accelerated rate when such was necessary

"In the Peninsula, when it was an object to take forward as great a quantity of ammunition as possible, the carts carried the whole 12 000 rounds, but to insure its getting on there was a necessity for its being drawn by four horses, and the same would have been necessary in France, on account of the deepness of the cross roads, had the cart been loaded to its full extent

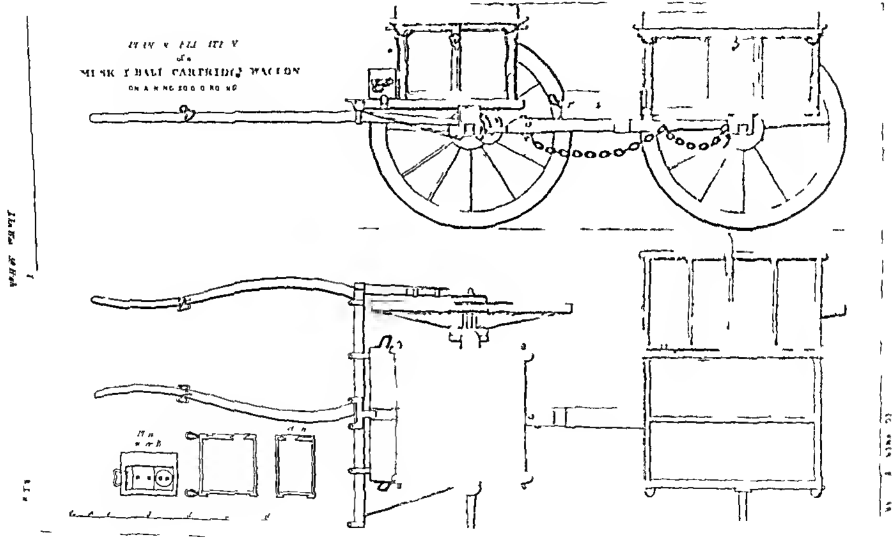
"From the above, therefore, it appears that the present ball-cartridge cart, with the reduced load, is too much for a pair, and that it will contain too little ammunition for four horses

"To remedy this inconvenience, therefore, the Committee are of opinion that four-wheeled carriages for small-arm ammunition would be far preferable to carts, and would afford the power of a better application of physical force for their movements

"The Committee have to shew, that although in their arrangement of field equipment the small arm ammunition limber waggons are proposed for 24 000 rounds, to move with four horses, it is not without having adverted to the increased weight of the carriages thus loaded beyond the ammunition carriages, which would render a diminution of ammunition necessary in the event of a difficult country at the same time it is deemed advisable that the waggon should be able to contain 20 000 rounds, in case the scene of operations admitted a facility of movement There would, as circumstances varied, therefore, be the power of regulating the movement of small-arm ammunition as follows In a good country, and the summer season the waggon might move with 20 000 rounds drawn by four horses; but in a difficult country, or a procrastinated campaign, the same load would require an additional pair of horses, and under any circumstances the service might be continued with four horses by diminishing the load of the waggon to 16 000 rounds, which its construction would admit of without danger of injuring the ammunition

"Another considerable advantage would be obtained also by the waggon being fitted for 20 000 rounds it would afford the means of bringing forward the greatest possible quantity from the *dépôts* and also *moving forward* a greater proportion to points of assembly preparatory to battles, or supply of advanced reserves, and which, in many instances, would admit of waggons being sent sooner to the rear for more ammunition.

"It may be argued in favour of two wheeled carriages that they would be more easy to conduct up great steeps, or extricate from difficulties, but reverting to the experience in Portugal, it may be considered as quite conclusive that a four wheeled carriage fairly horsed, like our ammunition limber waggon, can be conducted over *every species of country* where there is anything like a carriage road, and, on the other hand, the carriages with four wheels would possess the following important advantages over those with two



"There would be less wear and tear of horses than with carts when all work in shafts, and consequently fewer spare horses would be required with waggon reserves

"Carts would require to have all large, or what is termed wheel horses, whereas a mixed description of horse would be available for waggons to be distributed for wheel and leading, as is practised with batteries of artillery

"Should it be required to detach ammunition with great expedition from a waggon reserve, towards any given point, it might be done by taking the leading horses from half the waggons, and advancing the other half rapidly with six horses, or by unlimbering and sending the limbers alone with four horses, and this is an advantage which carts would not admit of, for want of leading harness The horses with waggons would be more ready to render mutual assistance to the carriages in difficulty than those with carts

"In case of retreat and being pressed by an enemy, should the horses be hard-worked and the roads very bad, considerable casualties would naturally be the consequence, which would occasion many carts being lost or destroyed, for it would be impossible for a cart to proceed with one horse, though a waggon could do with three, that is to say, if a reserve of twelve waggons was reduced to thirty six horses, it would still continue to move without diminution of carriage, whereas a reserve of twenty four carts, under similar circumstances, would be obliged to abandon six carts; besides, in the time of march, should a horse drop in a waggon, it would be easily extricated, and the waggon move on, whilst, by the same thing occurring with a cart, if a spare horse was not at hand, the movement of the column would be either interrupted, or the cart thrown out of the road"

Note—By a subsequent arrangement in the French Service, the musket ball ammunition equipments are associated with the field batteries attached to divisions of Infantry

ESCALADE.*

This article will comprehend three subjects

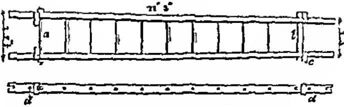
1 The Means of effecting this operation, *i e* the Scaling Ladder
2 The Arrangement before escalading works
3 The Execution

1 *There are two kinds of Scaling Ladder*, those in lengths, provided by Government with other Engineer stores, which have never yet been used—and those of an impromptu kind, made for the occasion the first description (used in the School of Instruction at Chatham) consists of ladders about 12 feet in length, which fit into one another, so that each joint will give an effective length of 10 feet; they are made tapering as explained in the annexed figures

Fig 1

* Compiled by Major General Lewis C B R E

Fig 2



Sides 3½" deep by 2" thick.—Yellow pine

a Iron rung of ¾" round iron
b Broad wooden rung: this and all except *a* are of oak
c Iron bands receiving the ends of the next ladder when fitted as in fig 1
d Lashing holes
Weight about 50 lbs

One length of Lieut General Pasley's ladder consists of two of the above joints and a half joint or short ladder 7' 6" in length, with the same widths at top and bottom, as given in fig 2.

The sides of the ladder to be of good yellow pine, all the rungs of oak except *a*, which is of ¾" bolt iron The clasps *b* to be of 2¼" × ¾" flat iron

The old regular pattern ladders, previous to the Peninsular War, were in lengths of 6 feet, very heavy, and when five or six were put together they broke down with their own weight: those used at Chatham are found to answer, and are extremely serviceable in practice, after having been brought to the most perfect state by various trials by Lieut General Pasley, at Chatham, they will likewise be found very convenient in the transport

The second description of ladder in one length, such as those by which the escalade at Badajos and other places was effected, are made of light but strong wood; those in common use in building are of one spar sawn in two, wooden rungs, with iron rods under them, at about every 10 feet apart, and are easily made by any carpenter when suitable timber can be had uffer poles are most esteemed in England In the campaign in Affghanistan the bamboo was used, according to Lieut Durand* In experiments made at Chatham it was, however, found that these canes could not be bored without weakening them too much the ladder, therefore, consisted of the two side pieces, and of rungs lashed across instead of passing through them

These ladders in one length are extremely difficult of carriage, for which reason waggons are constructed on purpose, and in mountain and bad roads, owing to the great length of the ladder, they are unfit for transport However, as they may be required again under similar circumstances, an account of them is here given

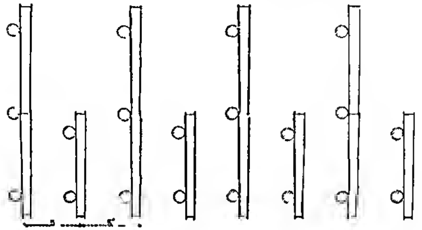
2 *The Arrangement for an Escalade*—The arrangement for the transport of the ladder is a previous question, depending upon the description used, and is more appropriately considered under the head of 'Equipment' It is presumed that they are carried to the spot by the Engineer Department, when the party intended for the escalade is to meet, unseen, and under cover if possible, 600 or 700 yards from work to be attacked. It is necessary, in order to be clear, to imagine the operation to be performed *either* by ladders in lengths or ladders entire for the first, the arrangements taught at Chatham will be the data; and for the latter, those proposed by Lieut-Colonel Jebb, in his 'Practical Treatise'

Ladders in lengths—It will be found convenient to fix them in double and single lengths alternately, as it is not possible to imagine any work to be escaladed less than

* Professional Papers vols iv and vi

10 feet in height the double lengths are made fast with the lashing usually fixed to the ladders, so that in lowering them down to descend a counterscarp they will not separate, they will be, therefore, spread on the ground, as explained below, in alternate double and single ladders, in reference to the work to be escaladed, and in rows, as may be best suited to the place of deposit, with the broad end to the front, at 4 or 5 feet apart.

Fig 3



There will be required, therefore, two men to each length.

Ladders entire will be arranged at 4 or 5 feet apart, and will require six men to each ladder to carry them to the escalade diagrams 4 to 9 will serve to explain the arrangement on the ground.

3 *The Arrangements for the Execution of an Escalade* —The attack of works by escalade may be conceived the reverse of other assaults, being performed in open order instead of close when approaching the place (for the *general* operations of an assault, see the article 'Assault') for the special operations the following suggestions are given, observing that it is immaterial whether there is a counterscarp or not, except that a greater number of ladders are required, and the operation will be described with *Ladders in lengths*, or with *Ladders entire* Supposing in the former the number of 10 feet joints available to be 180, and in the latter (entire) 60, the assaulting party will be supposed to consist, in both cases, of 400 men, with a supporting party of the same strength, the height of the escarps having been ascertained pretty accurately * observing that if there is a counterscarp, the ladders must be left there until the assault is over, which is sometimes omitted in instructions given, and which prevents the support following, and also renders the retreat impracticable. In all cases when there is a counterscarp, or that it is not very low, one third of the ladders should remain there, and consequently an adequate provision thought of hence it will be seen that the ladders in lengths are most convenient, as there would be no waste of material, which must be the case when they are entire, of 30 feet long, appearing an unnecessary height above the counterscarp, which would be the case were the ditch only 12 feet deep leaving, therefore, a proportion of single ladders on a counterscarp, the party with the double ones will fix them on the escarp raising them from below, if not of sufficient height, to fix one of more lengths, as may be,

* By the Engineer preparatory to the escalade

10 to 18 *feet requiring* 2 *lengths,*
18 to 28 „ „ 3 „
28 to 35 „ „ 4 „

but if possible the ladder should over reach the height of the escarp 3 feet, to assist to get a foot on the rampart or wall

The Escalade by Ladders in lengths—These are now supposed to be arranged on the ground The attacking party will be divided into—one half as the covering party, to extend themselves with their bellies on the ground, on the crest of the glacis, to keep under the fire as much as possible,—the other half *to be formed into* sections of five, with arms and accoutrements, but the slings slacked *Reverting to* fig 3, each party of five will move between the alternate short and long lengths, consisting of 60 of two lengths, and 60 of one length, three men taking the long one, and two the other, on their right shoulders, having previously slung the musket (*bayonet unfixed*) *over their left* On the word 'forward' the party will move onward, preceded by the Engineers, assisted by a detachment of Sappers, provided with axes and crow-bars, to the point of attack, between the files of the covering party On reaching the *escarp* (the descent into the ditch being explained and provided for if there is a counterscarp) the threes with the double ladder will rear it by planting the butt end firmly on the ground; and conceiving, by way of example, the *escarp* or exterior revetment to be above 18 feet in height, the third ladder will be used by raising the double one and fixing the other below this method will not be difficult, by extending the bottom of the first as far as possible from the wall, and then hoisting up all three an escalade above 25 or 28 feet is rarely practicable except by surprise * When the ladders are thus raised, the men will fix bayonets, carrying their muskets slung on their left arms, for the purpose of having a good hold of the ladder until near the top those who precede should be provided with a sap hook, *to secure a good footing* on the parapet, and the sap hook is not a bad weapon if a personal encounter does occur thus fixed, the advanced men of each ladder can give great assistance to those who follow

The Escalade by Ladders entire—This operation being preceded by the ladders being arranged similar to what is described in figs 4 to 9,—the attacking party, as before, divided into two, one half the covering party,—the other will be divided into sections of six, and move between the spaces of the sixty long or entire ladders, of about 30 feet in length,—when so posted, on the word 'forward,' with the arms slung, they will proceed to the attack if there is a counterscarp, the whole of the ladders will be placed to descend, and when in the ditch two thirds or forty will be carried forward butt on, according to Lieut-Col Jebb (in figs 9 to 12), and raised against the escarp or exterior revetment, bayonets now fixed, and the escalade attempted, as before explained, the leading men of each ladder being provided with a sap-hook It will be seen with these long ladders, that there is much difficulty in turning them over, particularly under fire, as they must be spread over very much of the breadth of the ditch † But all escalades, to be successful, must be a sort of

* Vauban considered 36 feet French or 38 feet 4 inches English to be beyond escalade

† "All the ladders used this night ‡ were the ordinary ladders of the English mechanics and were made during the course of the siege There were twelve supplied for this escalade, and the same number for General Leith s They were called 30 feet ladders but some of the longest measured 32 feet and three or four not more than 28 feet

* The *experience of all the escalades* in the Peninsula leads to the belief that such description of

‡ Storming of Badajos

surprise, as against a garrison taken unawares or otherwise occupied in a real or a false attack they should be apparently desultory, and at various places, and moreover well supported by a reserve

This operation is given by Lieut.-Col Jebb in fuller detail as follows:

"We have three companies in line, and we wish to carry the ladders forward so that the front rank of the centre company shall be placed in a position to ascend the ladders first and afterwards to stand at the head of a double column of subdivisions formed upon it —we will say 20 yards in front of where the ladders are placed. The ladders are supposed to be laid out all ready on the ground, in front of the line, fig 4 The cautions and words of command might be as follows

"Form quarter distance column in rear of the two centre subdivisions See fig 5	According to regulation
"By files extend from the centre and cover the ladders "Outwards face—or Outwards close—Quick march.	The corresponding files of the 3 subdivisions would halt and cover the ladders in succession; the ladders and files having been previously numbered from centre to flanks.

Fig 4

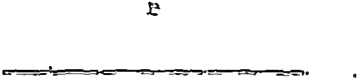
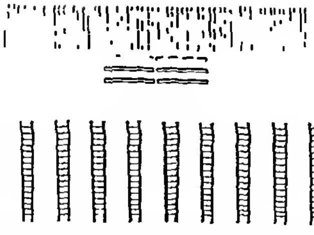


Fig 5



ladder is the best that can be used. The greatest difficulty experienced was to bring such unwieldy machines to the spot but once there they were raised readily enough when not seriously opposed

"Had the jointed scaling ladders supplied as an Engineer store * been sufficiently strong for the purposes of an escalade, they could not have been put together under the fire and missiles poured down on the assailants from the parapet on these occasions; and should any *more perfect jointed* ladders be substituted, it will always be found necessary to put them together *before* the garrison discover the party

"These unwieldy ladders travelled on cars many marches with the army but they are so readily

* The old pattern alluded to in the beginning of this article not those of Lieut.-General Sir Chas Pasley

"The files would then be in the position shewn in *fig* 6, and the rear rank men would merely have to step up into the same alignment as the *front* rank, instead of covering

Fig 6

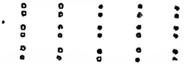
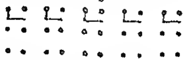
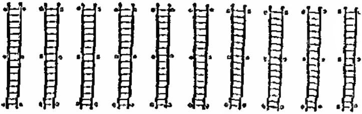


Fig 7



them (as shewn in fig 7), and then being moved forward and file I between the ladders (*fig* 8), *they would be ready to* advance with them in line, and by preserving

Fig 8



the order in which they then stood, or something like it, in ascending out of the ditch, they would be in their places for re-forming the double column again, in the situation required.

"It may be said, this is all very fine and regular, but how is such order to be preserved under a heavy and destructive fire? We answer,—the greater the probability of confusion, the greater is the necessity of taking every possible precaution to lessen the chance of it, and obviate its effects It is not pretended that in the heat of action men could exactly keep their places,—the impetuosity and keenness of the many, and the *caution* of the few, would of itself prevent it,—but every man would be in his *right place*, when at the bottom of the ditch, for securing this formation, and they could not well be much out of it, in a compact column of three companies,—formed within so limited a distance to their front

"This explanatory digression being ended, we must revert to where it commenced, and suppose the two lines of ladders are laid out, and that the men disposed on the above system are in readiness to take them up The most convenient way of carrying ladders is on the shoulder (*fig* 9), when therefore they were thus *raised*, *the line*

Fig 9.

would be in readiness to advance, and in as close order as is practicable, which it may be observed, *en passant*, is a point to be attended to

"The firing party would precede the ladders, and act according to circumstances,

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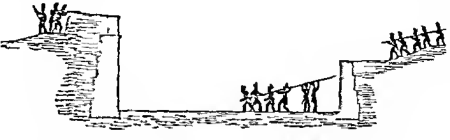
made when required that it can seldom be worth the trouble of removing them from place to place Their weight and strength were considered great advantages when once raised as there were many hard struggles between *those above to throw over*, and those below to support the ladders, which would have broken less sol d machines

[1] It is believed that the honour of raising and forcing up the first ladder, on this occas on attaches to Lieut.-Colonel Ridge in command of the 5th regiment, who met his fate on the castle wall '—*Jones's 'Sieges' Note* 21 *third edition*

the object being to keep down the fire from the parapets or embrasures,—to prevent the enemy shewing himself or making any attempt to throw the ladders back—or in any way to arrogate to himself the right of assuming the offensive, outside the parapet any such attempt should be regarded as a decided case of trespass and should be dealt with accordingly

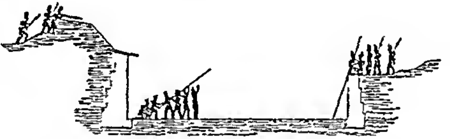
"The leading division, on arriving at the spot, would lower the ladders into the ditch (fig 10), and the men would immediately descend, and when they were all

Fig 10



down would instantly shift them over to the opposite side, planting the foot of each ladder against the bottom of the scarp and then turning the top over (fig 11) the

Fig 11



foot being afterwards dragged away from the wall about one pace, to give it a little inclination, but the less it has the better, for the more upright the stronger it will be, and it is also easier for the men to ascend than when there is much slope. The moment the first division of ladders were out of the way, the second would be lowered into the place from which they had been removed (fig 11), and the men carrying them would in like manner descend, but those ladders would not be shifted across the ditch but left where they were first lowered, and thus a complete communication would be established, by which the remainder of the storming party, and the support, could follow in close succession.

"With a still more scanty supply of ladders, or with greater means of resistance to be overcome,—in fact, where it would be very desirable to have the *whole* of the disposable ladders reared against the scarp for making the attack,—we must not be deterred from the attempt by apparent difficulties. Send them all on in one line if it *must* be so, carried by six men. Let another division of men descend before they are shifted across the ditch, and let the support jump down upon bags of hay, as they did at Badajos! Throwing a force into confusion, and letting men roll one over the other will signify nothing in an escalade, in comparison of the evil effects which result from breaking the ranks of a close column on the eve of rushing forward to assault a breach, *that* is to be avoided by every possible means But with

"The files would then be in the position shewn in fig 6, and the rear rank men would merely have to step up into the same alignment as the front rank, instead of covering

Fig 6

Fig 7

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Fig 8

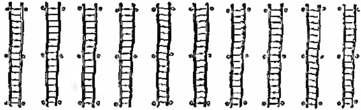

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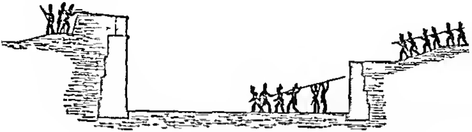
Fig. 10



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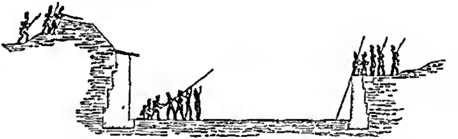

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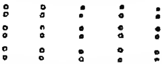

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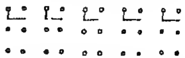

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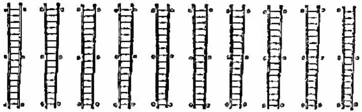

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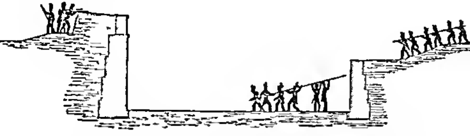

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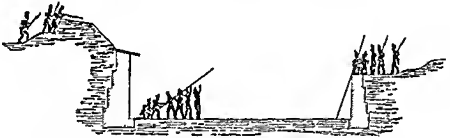

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But taking into account the variety of ground in which troops must be capable of acting and the difficulty of training men to a perfectly uniform rate of march, 50 files may be assumed as the maximum development which ought to be given to the element (or the fraction)—a Company, and between 30 and 40 files a convenient strength for manœuvring

Excepting on ground which is absolutely rugged, a line consisting of between 30 and 40 files ought to be able to march and to wheel without the *order of its formation* being materially deranged

II Number of Companies which ought to constitute the Battalion

Symmetrical manœuvres, such as the formation of squares and of double columns, require that the Battalions should be always composed of an even number of Companies

Whether it be composed of 4, 6, 8, or 10 Companies is a matter of no tactical importance, but when columns of the same strength manœuvre together in masses, it is desirable that the number of the divisions and the intervals between them should be so proportioned to the extent of their front that, in close column, the front should not exceed the depth of the column.—See 'Field Exercises,' Part IV Sec. 4

Subdivisions sections, and sections of threes, are useful in defiling, and in some manœuvres, but these minute subdivisions are so liable to derangement from casualties that they ought to be considered, not as primary and fundamental parts of military organization, but merely as secondary and occasional aids to facilitate the working of the system

In defiling it may be suggested, that it would be convenient to tell off the troops in sections corresponding to the breadth of the defile, without reference to the manner in which the Company is usually subdivided.

It now remains to examine the constitution of masses consisting of the aggregation of several tactical units

If it were attempted to determine the composition of a Division consisting of several Battalions according to a definite principle, then, by an extension of that used to determine the strength of the Battalion, the idea would naturally suggest itself of *composing* the Division of as many Battalions as the Battalion contains Companies

The front of such a mass of Battalions formed in contiguous columns would not much exceed the front of a single Battalion deployed, and such a mass might, therefore, be manœuvred by the direct command of its chief with nearly the same facility as a single Battalion

The constitution of the Divisions composing the Peninsular army was similar to that here suggested, but it is not meant to be asserted that this constitution was determined by the analogy pointed out as subsisting between it and the constitution of the Battalion

In the Duke of Wellington's army, the Division of ten *Battalions* was *further* organized in three Brigades, for the adoption of which subdivision the writer of this article is not aware that any purely tactical reason can be given.

Military organization, besides its tactical uses, is necessary to carry into effect administrative and logistic arrangements

With reference to these arrangements, the classification of Battalions in divisions and brigades is of the greatest importance, but it is certainly erroneous to suppose that it is consistent with the usual practice of armies to adhere strictly to systematic analogies in the tactical arrangement and distribution of an army in the field, or to imagine that such precision, if attempted, would be suitable to the circumstances of war

When manœuvring in presence of an enemy, a General estimates his force accord-

ing to the number of Battalions of which it is composed, and, considering these Battalions as independent bodies, he combines them without regard to the preservation of the unity of brigades or divisions, in reserves and columns of attack, each consisting of a number of Battalions proportioned to the object it is intended to fulfil, and each liable to vary in its strength when circumstances require fresh combinations.

It is these Columns and Reserves, and not Divisions and Brigades, which constitute the real tactical divisions of an army.

A Reserve, consisting of a mass of several brigades, will frequently be estimated and employed by a General as a single quantity, while a detached Battalion occupying an essential point, may sometimes enter into his calculations as a separate and important element.

EVOLUTIONS.*

"Il faut des évolutions, car sans évolution, une troupe ne serait qu'une masse sans mouvement, réduite à l'ordre primitif dans lequel on l'aurait placée, et incapable d'agir au premier changement de terrein ou des circonstances. Les évolutions sont donc les mouvemens par lesquels une troupe doit, relativement aux circonstances et au terrein, changer d'ordre et de situation.

"Elles doivent être simples, faciles, en petit nombre et relatives à la guerre."—*Guibert, Essai Général de Tactique. Tactique d'Infanterie*, chap. v.

If we examine the Evolutions prescribed in existing systems of Tactics, we shall find that it is not in all cases the simplest and shortest methods which have been chosen for effecting changes in the position and direction of the line of battle. In changes of front to the rear, for instance, a battalion does not simply face to the right about, but the change is effected by a tedious series of counter marches.

. . . .

Subjecting the formation of the line to the condition of the preservation of the parts of which it is composed in a certain fixed order has the disadvantage of complicating the theory of military movements, and occasionally of producing perplexity in their execution.

It would greatly increase the flexibility of military bodies if the utmost freedom of inversion were permitted, if the system of arbitrarily determining the front and rear, and the right and left flanks of a division, and of framing a system of manœuvres with reference to the preservation of these distinctions, were abandoned, and if, instead of permitting inversions as an exception as is now the case, it were established as a general principle that the line should invariably be formed by the simplest and shortest possible process, without the least regard to which rank of a division might be placed in front, or which of its flanks on the right or left of the line.

As however this principle is not recognized otherwise than as an exception by any existing system of tactics, it is sufficient to suggest the possibility of its extended

* Lloyd observes that all Infantry Evolutions are but means of forming Line or forming Column: to these may be added, in the British Service, the four-deep square; so that all *drill* may be carried on as a series of changes on the different elements.—Line, Column, Square.—Line, Square, Column.—Column, Line, Square, &c., &c., &c., whether referring to the Company, Battalion, or Brigade.—*Editors.*

Chief and depends on considerations quite unconnected with the training of troops, or with any particular system of evolutions

But, on the other hand, the rapid and regular execution of these arrangements, which alone can render them successful, entirely depends on the existence of a well-organized system of evolutions, on the skilful application of that system by the Officers in command of *corps* and *battalions*, and, *above all*, *on each individual soldier* being carefully trained to obey implicitly, to move steadily, to form rapidly, and under no circumstances of danger or difficulty ever for an instant to forget that instinct of combination and immediate and implicit obedience which is the essence of military strength

It is only when a body of men is thus constituted that its numbers become formidable, and its energies available for great achievements Numbers without order, instead of contributing to strength only serve to render more disastrous the consequences of weakness

Valour without discipline, so far from being sufficient to secure success, has frequently no other effect than to precipitate the moment of ruin

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NOTES

1 The word 'Tactics' is in this article used to denote the science of military formations and movements

2 Without appealing to the experience of those who are familiar with what occurs in actual warfare, every one who has witnessed even a *Field Day* knows that firing has a tendency to loosen the files If, therefore the natural order were found to be the best, and adopted as the rule of formation, would it not follow that the divisions of a battalion ought to deploy with intervals between them, so as to admit of the files being loosened without confusion?

There is no tactical point of greater importance, or which is worthy of more careful investigation than the determination of the most advantageous mode of occupying ground, *that is to say, the extent of front being given the determination of the* number of men and the manner of disposing them, whereby the most effective fire can be secured for its defence

The importance of this point being accurately determined will be manifest, if it be considered that both the development of the line of battle and the proportion of casualties have obviously a direct dependence on the density of the formation

3 The means of keeping this force effective, or the determination of an establishment for the battalion which shall be adequate for supporting the casualties incident to military service, is a question which is perfectly distinct from the determination of its proper effective force This question of the establishment which corresponds to a given effective force is both interesting and important, but it depends on considerations which do not belong to the subject of tactics (as defined in Note 1); it cannot, therefore, be discussed in this place

4 If part of a line be marching on level ground and part on a slope, in order to preserve a correct alignment, the rates of march of these two sections must be unequal, since it is evident that the section on level ground is traversing the side, and the section on the slope the hypothenuse of a right angled triangle

5 One of the manœuvres practised in the French army is the wheel of the

battalion in line The wheel and echellon march of battalions is one of the methods prescribed in the 'Ordonnance' for changing the front of extensive lines

6 Supposing the battalion to consist of 800 men, if composed of eight divisions, the front of a division would occupy 35 paces, which, in order that the depth may not exceed the front of the column requires that a division and its interval shall not occupy more than five paces If organized in ten companies, the front of a division would occupy 28 paces, which, preserving this ratio between the front and depth of the column, would only allow three paces for a division and its interval

7 The Roman legion has been often cited and studied as a model for the organization of large military bodies, it must not, however, be supposed that in the formation of the line of battle each legion was always arrayed as a distinct corps, and that parts composing it were invariably kept together and disposed in the same order

On the contrary, we find that the cohorts of different legions, like the battalions of different divisions, were sometimes detached, and arranged not according to any system of tactical organization, but in the way which was most suitable to existing circumstances E G —Cæsar, in his 'Commentaries on the Civil War,' informs us that on one occasion, when manœuvring against Afranius, he drew up his army in three lines, that his first line consisted of 20 cohorts four from each of his five legions, that his other two lines each consisted of 18 cohorts, viz. 3 auxiliary and 3 from each legion, or 15 legionary cohorts

"Cæsaris (acies) triplex sed primam aciem quaternæ cohortes ex quinque legionibus tenebant, has subsidiariæ ternæ, et rursus aliæ totidem, suæ cujusque legionis subsequebantur"—*Com de Bel. Civ* lib. i. lxxxiii

8. The method of changing the direction of a mass of columns practised by the garrison of Dublin in 1844 was similar to the first of the two annexed French methods of performing this manœuvre

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THE MARCH OF INFANTRY CONSIDERED AS A BRANCH OF SPECIAL TACTICS

"Tout le secret de la Tactique est dans les jambes"—*Les Rêveries du Maréchal Saxe*

Not only when viewed in relation to the science of General Tactics but also when considered as a branch of Special Tactics the subject of marching presents itself under two different aspects, and in treating of the details connected with the marching of troops, as well as when treating generally of the movement of masses, it is necessary to keep in view the distinction which exists between marches of route and marches of manœuvre

The objects of these two species of marches are essentially different, and in order to perceive distinctly, and to appreciate justly, the principles by which each species ought to be regulated, a definite idea must be formed of the nature of these objects

I ROUTE MARCHING

To traverse the greatest possible space in the least possible time, and with the least possible fatigue to the troops, may be defined to be the object of route-marching

Chief and depends on considerations quite unconnected with the training of troops, or with any particular system of evolutions

But, on the other hand, the rapid and regular execution of these arrangements, which alone can render them successful, entirely depends on the existence of a well-organized system of evolutions, on the skilful application of that system by the Officers in command of corps and battalions and, above all on each individual soldier being carefully trained to obey implicitly, to move steadily, to form rapidly, and under no circumstances of danger or difficulty ever for an instant to forget that instinct of combination and immediate and implicit obedience which is the essence of military strength

It is only when a body of men is thus constituted that its numbers become formidable, and its energies available for great achievements Numbers without order, instead of contributing to strength only serve to render more disastrous the consequences of weakness

Valour without discipline, so far from being sufficient to secure success, has frequently no other effect than to precipitate the moment of ruin

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TABLE II

Lengths of Pace and Rates of March established by Regulation in several different Armies

Name of Nation	Name of pace	Length of Pace: Foreign Measures	Length of Pace: British inches	Rates of March: No of paces per minute	Rates of March: Yards per minute
British . .	Slow step Quick step Double step		30 do 36	75 108 150	62 5 90 150
French . . .	Pas ordinaire Pas accéleré Pas redoublé	65 centimetres Do Not given	25 59 do. not given	76 100 140 to 150	54 02 71 11
Prussian . .	Ordinairer schritt Geschwind schritt For the charge	2 fuss 4 zoll Rhinlandmeasure Do Not given.	28 83 do.	75 108 120	60 06 86 49
Austrian . .					
Russian . .					
Spanish	Paso regular Paso redoblado	2 pies Do.	22 25 do	76 120	46 97 74 17
United States .	Common step Quick step		28 do	90 120	70 93 33
Ancient Roman	Passus Militaris(§)		29 18		
Average . .	Slow step Quick step		27 31 do	78 4 111 2	59 47 84 36

Note —The length of the Roman pace has been calculated on supposition of there being 75 Roman miles of 100 double paces to a degree. The Prussian rates of march have been taken from Scharnhorst, the others from the Regulations of the different Services

In making the reductions the following values have been adopted:

Metre . . . =39 37 *inches*
Rhinland foot =12 356 „
Burgos foot . =11 128 „

EVOLUTIONS OF ARTILLERY.*

ARTILLERY ACTING WITH OTHER TROOPS

1 When artillery is attached to other troops, and its movements are to be regulated by them, the Commander should manœuvre so as not to interrupt them

2 He (as well as every other Officer) should be well acquainted with the evolutions of troops, for he will then know the ground which they will go over in performing

* From Instructions and Regulations for Field Battery Exercise'

any manœuvre, and will never impede them; moreover, he will be enabled to arrive more quickly at the position he is to occupy.

3. Though in matters of review the artillery should generally conform as nearly as possible to the movements of the troops, yet a latitude should be given to the Commander to depart from this rule whenever he may see it necessary, and when he thinks he may attain his object by acting differently.

4. In all alignments of troops, the artillery should never be brought up nearer than sixty yards from the intended alignment, till the points of it are finally established, when the Commander will move it up to its position, twenty yards in rear of the line, where it will remain: by this means, should the whole move to a flank, the artillery will be clear of the line of points.

5. When the artillery is ordered into line, or, at review, when the General is about to appear, Nos. 1 of each subdivision move out, and place themselves one pace and a half in rear of the front rank of the troops, and facing to their subdivisions. The artillery move forward, Nos. 1 halting their subdivisions when the leaders come up to their own persons.

6. Should the artillery be ordered for action, and be required to fire, it will move forward previous to its unlimbering.

7. When the guns are in action, the muzzles are to be in a line with the front rank; and when they are ordered to limber up to the front, they must be run back so as to leave the alignment clear.

8. The artillery should always cover the troops when advancing, retiring, or deploying into line.

9. In line, the artillery will generally be placed on the flank of the troops to which it is attached; and if there be no other troops on the outward flank, there will be sufficient room for it to move freely. When, however, it is to be drawn up between two bodies of troops, it must manœuvre as much as possible on its own ground. The Table at the end* shows the number of yards for a battery of six guns in line and in column. With less, the artillery will be contracted.

10. The distance which artillery can move in advance of a line must always depend upon the support it can receive from the troops or covering party, and from the nature of the ground. The Commander must always be guided by the position and manœuvres of the enemy. Should there be any favourable positions, or ridges or swells in the ground, advantage should be taken to place the limbers under cover.

11. If the line is to advance after deployment, the artillery must gain ground to the front, while taking ground to the flank to uncover the troops as they deploy.

12. When the line advances and approaches the battery which covers the advance, the Commander will, in proper time, push forward the half batteries alternately, either limbered up or with the prolonge.

13. When artillery is in action on the flank of a line, it should, in general, be placed more or less in echelon, in order to fire obliquely on the enemy in front.

14. When the line retires by alternate companies, wings, or battalions, the artillery must remain with that part of it which is nearest the enemy, retiring with the prolonge, and halt when it arrives with the halted part of the line.

15. When the line changes front to a flank on its centre, the artillery, with the flank thrown back, should cover it, retiring with the prolonges; the artillery on the other flank covers its advance.

16. When the line is thrown backward or forward on one of its flanks, some of the guns nearest the halted flank may be run into line by hand.

* See 'Instructions and Regulations for Field Battery Exercise.'

all affected by igneous disturbances, such as at certain points of the Great Fish River Valley, near De Bruin's Post, and still more so half way between it and Graham's Town, or in the tributary ravine of the Ecca in South Africa This formality of shape is particularly conspicuous when the courses of the different streams either coincide with the dip and strike of the strata, or else directly cut through them at right angles Certain portions of the Rhine (in the same rock) are equally rectangular, and the Rhone is probably still more so Fig 7 is the Delta terminating figs 5 and 6, but only on the alluvial deposits at the mouth, beginning from the point where the valley ends.

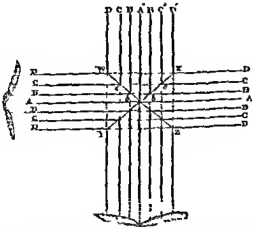
Valleys, however, are not simply composed of two slopes, A X, A Y, (as shewn in section, fig 8,) intersecting at the river A, but in general of several successive planes sloping down from the water sheds (X X', fig 9), such as X D, D C, C B, B A, either meeting on both sides in A, or separated by a flat valley bottom, A A'.

Fig 8

Fig 9

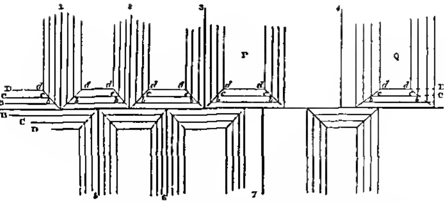
If two such valleys intersect one another, as in fig 10, there will be a groin shaped space (W X Y Z) formed, and it is of the greatest importance in sketching ground that the general form of the main valley be traced out by the significant correspondence pointed out by the dotted lines, between the truncated portions (D W — X D, $c c$ — $c c$, B b — b B, &c), and as if the general trench-shaped primary valley had never been invaded by the cross one

Fig 10



Thus, in fig 11, in representing the main valley A A, with its cross ravines, 1, 2, 3 &c , the original lines (D D) must still be indicated (or dotted out, as it were) by the fragments $d d$ — $d d$ — $d d$, &c , C C, by $c c$ — $c c$ — $c c$, &c

Fig 11



In Plate V the principle is applied to a river (A) between the two water sheds (W X Y Z): the whole valley between these lines should be sketched with the feeling that the stripes or zones (across the mouths of ravines Nos 1 2 3) ee e e e″e″—dd d′d′ d″d″—cc c c c″c″ &c are still in existence. The same applies to the ravines themselves in reference to their own branches as in ravine No 4.

Attention to this is indispensable as a principal means of *representing ground as a whole* in the manner adverted to in the earlier part of this article.

It should be remarked that where a river runs along a broad valley flat as on A A (fig 9) that it constantly changes its direction as if repulsed and rebounding from one side to the other and at all sudden turns is to be found under the concave sides. On these last the banks will be steepest even to being perpendicular cliffs as is particularly observable in rocks with tolerably horizontal strata (*e g*) the Wye between Chepstow and Tintern (Plate IV) or the Dove in Dovedale both in mountain limestone or the Great Fish River with its bluff kranzes in which it often amounts to flint slate. In Plate V this alteration of steepness has been neglected for the sake of simplicity and the section E A E (fig 9) has been followed rather than E A A E. This changing from side to side may likewise be observed on a good scale in many harbours and estuaries such as Portsmouth and the Hamoaze at Devonport but more especially in their branches and creeks in which at low tide this alternation of sides gives a good clue how to find the channel at high tides even when guiding a party of boats in an expedition where one is a perfect stranger to the locality.

Referring to the last paragraph but one and still in pursuance of the idea of representing ground as a whole as far as it may be done without forcing and exaggerating what at times is scarcely perceptible (as for instance in considerable tracts of the chalk districts if taken at all in detail) something must be said of the first order of master lines—the water shed or summit ridge—as equally important with the water course though not always so readily appreciable very seldom appearing in the finished sketch and therefore spoken of last though almost the first to be indicated in pencil.

Although for the sake of illustration these ridge lines are given in the different accompanying diagrams yet they are in dotted lines only as they are never expressed in drawings unless they should accidentally coincide with some otherwise marked feature line as for instance at *b b* Plate II by a sharp ridge of rocks happening to run along the water shed. Notice of them is nevertheless indispensable in original sketches as fundamental memoranda though they need then only be given as above mentioned in pencil.

In Class B, water-sheds, as shewn by dotted lines in Plate I. fig. 6, may be considered as always so co-ordinate with the water-courses that they may be almost invariably deduced from them,* and appended to the main ridges (W X, Y Z), as the streams are to the main river (A A).

In Classes A and C, the subjects are too wild for any such formal connection. In the former, no particular representation is necessary, as the sand-hills vary in form and position with every wind, and it is therefore correct to express them conventionally, instead of specifically. In the latter class (C) the ridges are either those of forms of explosion, or else of lava torrents bursting out arbitrarily from any point in the sides of the volcanic cones, and far oftener so than from the main crater. In Classes E and F, as level surfaces, there is no appearance of this line, except perhaps, where F, lying on, and thus forming part of, the high grounds, may happen to cross it. In Class D, as composed of B and C, there will be a combination of the principles of both; and, as before intimated, those of C (or their cognate effects, as forms of disruption amongst stratified masses) will generally be prevalent in the upper, and those of B in the lower ground.

ORDER III.

THE COAST, OR HORIZONTAL CONTOUR LINE.

So far as the forms of ground have tolerably distinct outlines, as given either by a somewhat obvious ridge, or by the water lines, or by the boundaries of the various faces produced by the above-mentioned continual intersection of valleys, they may be given, as approximates to mathematical forms, in little more than clear outline, as far as the 'Field Sketch' is concerned; but it may also happen that the section of the ground may be too low, and its shape no longer defined by facets (as if in a measure polyhedral) but by curved surfaces, both in plan and section.

It is then that horizontal 'contour lines' are called in to assist in the representation. They are such as would be given by successive risings of a flood to different levels: these will, in the first instance, start from the coast, though they soon lose all exact parallelism thereto, when the supposed waters, as they rise, find their way into valleys, and rise up the faces of the hills. It is evident that if ground be surveyed in this manner, and the heights of the different levels given, the plan of these contours presents the equivalent of a complete model of the ground.—See 'Contouring,' also the dotted lines of Plate II.

It is very desirable that the student should practise this operation to a considerable extent, as he will obtain thereby a knowledge of the true forms of ground which cannot be had in any other way; though the nearest approach to this will be given by the mud bank model. When on a hill, the eye takes in so little at a time, that if not thus disciplined, a beginner is sure to give too great a roundness and circular formality to his forms. A like remark applies to sections, which are sure to be made too steep by the tyro, who, apt to estimate steepness by the fatigues of ascent, is generally much surprised at the low relief of ground with apparently considerable elevation and abruptness, on making his first section of the same. It is on this

* Near Freyenwalde.

account very desirable to study your ground at a distance, (for general correction as to relative importance of the different features) as soon as the local details have been collected on the spot. The best times for this are a little after sunrise or a little before sunset.

These horizontal outlines (of horizontal sections) are strictly applicable to sketching, with regard to the shading touches being also horizontal, or nearly so. This style is very generally used at present, in preference to the vertical mode, which, however, is by some considered to have greater force in the expression of very steep ground, and is, perhaps, more easily understood in hasty sketches, where but little detail is admissible; though both styles become objectionable where they are made, unnecessarily, to supersede the simple outline for the main features, where this (the outline) would be clearer, and more rapidly executed than any quantity of shading.

As memoranda for subsequent study and completion, the best plan is to combine both, as shewn in Plate II; but when everything must be made to speak as simply and quickly as possible, this would be a misplaced and not generally comprehensible refinement,—and the rough but significant hieroglyphics of Plate XI are far preferable.

The relation of this Order III to I and II is best seen by supposing, either on the mud bank model, or on the actual face of the earth, what changes of topographical nomenclature are dependent on the supposed elevation or depression of the waters above or below the present level—when the inland sea, the gulf, the bay, the lake, become the grand valley, or the mountain basin, convertibly.

Let the waters retire sufficiently, and the bed of the Mediterranean becomes the grand valley of a new river, issuing from between the Pillars of Hercules, as the conjoint result of the Nile, the Danube, Don, Dneister, and Po, besides numerous other new rivers of respectable magnitude. Let the waters rise, and Bohemia reverts to its probably former condition as a lake, of about the size of Lake Superior, the upper Alps become bold groups of islands, and the whole space now occupied by the Amazon and its branches resumes the character of an immense gulf, as large, perhaps, as both the Bay of Mexico and the Carib Sea together.—See Lyell's Geology, Plate II (of 4th edition) shewing Europe as an archipelago at or about the commencement of the older Tertiary.

Thus the name and character of Order I, either as the Line of Shallowest Soundings, or as the Water shed,—or of Order II, as the Channel of the Deep, or as the Water-course,—are terms depending entirely for their application on the level of the Third Order; and in the orthographic expression of ground, no one may decide on their relative importance. The First and Second are indefinite and unmeaning without the Third, and the Third is mechanical and spiritless without the First and Second.

The 'Contour' is particularly applicable to Classes E and F, especially the former, as peat formations are not exclusively, though very generally, confined to level, and especially lower grounds: abundance of water is indispensable to the plants of which they are composed, and as water is to be found on the side of a hill, as well as at the top or bottom, the peat plant (generally Sphagnum Palustre in Britain and Ireland) will be found in any of these positions. In the Irish insular groups of hills, before mentioned, a very large proportion of the flat grounds thus representing water is filled with it, as the *sine quâ non* of the existence of these vegetable formations.

The masses of animal and vegetable* skeletons composing the coral formations are

* Corals are not exclusively produced by animals, they are extensively secreted by marine plants, and amongst the animals whose skeletons are thus accumulated, the Zoophyte (as is generally

necessarily (especially when incomplete) exclusively arranged in contours—whether round nuclei of Classes A, B, C, or D, they conform to coast lines, or aggregate round the heads of sub marine hills, in belts which cannot in any case rise above spring flood tides, and very generally—depending on the nature of the animal or plant—above those of the spring ebb Whether these belts fill in subsequently or not, the external contour remains unaltered

SUBORDINATE LINES,

such as a, a, a a_1 in Plate II, occupy the same rank in the delineation of ground that the markings of the muscles folds of flesh, &c, would in the representation of the body, after the main outlines, descriptive of the head eyes, limbs, &c, have been given —as thus subordinate, they are termed Minor Feature Lines Where they refer to curved surfaces, they will be made somewhat to swell towards the centre, as would be done in the line that would express a cheek, a muscle, &c : they will be more rigid as the forms become more angular The study of Plate II is particularly recommended to the student

SECTION II.

PRELIMINARY ARRANGEMENTS FOR FIELD SKETCHING

The whole district to be represented should be apportioned off to the assistants by the person who is responsible for the combination of the different parts

The assistants should work together in the first instance at their common boundaries, to such extent as will insure agreement on the lines separating their respective portions

To effect this agreement and general consistency, the skeleton diagram of the whole should be formed from the best and available authorities, giving the positions of the main points If there be no trustworthy maps to supply these, they must be obtained trigonometrically, if the space exceed about 10 miles square, and the scale be greater than 2 inches to the mile* It is in vain to expect accuracy, or even tolerable general coincidence amongst the parts, when every man works quite independently and without triangulation

Each assistant should receive his sheet with those points *pricked off* from the general diagram that concern himself, and which will therefore include many of those surrounding, but not on, his own ground of these he should make as much use as he can, so that as much as possible of the work may be relatively right, notwithstanding the moderate amount of absolute error which ought to be expected on this duty The meridian should likewise be given from the general diagram

INSTRUMENTS, &C

Necessary to be prepared for Field Sketching with advantage

The sheet should be *well* supplied with fixed points as above

The meridians ruled as normal lines, either at fixed distances (see Plate VIII) say 1 inch (or ½ mile) apart,—or else passing through the main points both plans have their advantages

The paper should be stretched so that the edges be secured from the wind, and

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assumed) is by no means the sole constructor: Serpula, and probably many others contribute largely to these formations

* A carefully chained base and the skilful use of the pocket sextant will provide for this space if the points are not much more than two miles apart it will not be necessary to compute the distances trigonometrically but to lay these down by the protractor, constructionally as in Plate VII

there should be the means of covering it from the rain. Where, as in Section III, there is leisure and convenience, experience has shewn that a board, even of the size of a sheet of demy paper, (hinged in the middle, made of the thinnest and lightest wood that will bear the *framing* at the edges necessary to prevent warping, and supplied with a flanged Macintosh bag as a cover, fitted with a strap for slinging it over the shoulder,) amply repays the trivial inconvenience of carrying it by the additional number of surrounding points that it can include. When, as in Section IV., this would be out of the question, the sketch book described in the note to Section IV., and tested by the long and arduous experience of Colonel Bainbrigge,* leaves nothing to be desired: with this last, portions only, such as single lines of road from point to point, and the ground immediately adjacent, are sketched at a time (see Plate VI.), and are combined on a general skeleton afterwards. The hinged board has the advantage of enabling one to complete everything on the spot (a skilful sketcher need rarely go over the same ground twice, where there is no impediment to his movements,) and thus becomes a convenient substitute for the somewhat antiquated plane table.

The only instruments generally necessary in field sketching are, a Schmalcalder's compass and a drawing scale; but in basaltic districts, or any other in which iron in a form capable of affecting the needle† abounds, instruments for taking included angles instead of bearings must be substituted, such as Colonel Bainbrigge's field goniometer, or the pocket sextant,—the former being by far the most satisfactory invention on the reflecting principle as yet invented.‡

The most convenient drawing scale is the white metal, or even the common ivory protractor, 6" x 2", three edges occupied by degrees,§ the fourth cut to 40 to 1 inch, as a very useful scale for general use, being applicable to any multiple or sub-multiple of the mile (or 80 chains), especially when two inches to the mile is adopted, which is very commonly the case for the general sketch, of which parts can be enlarged subsequently for positions, lines, &c., as may be required. If preferred, this fourth edge can be cut to the paces per mile of the draughtsman: when this is not done, it will save much time, and possibly error, to have a small table of paces (peculiar to each person) as far as 20 chains, engraved on the scale. (See Plate VIII.)

The best material for sketching on is the Bank post paper: when well made it is remarkably tough, and though thin enough for tracing through, yet it stands a great deal of severe work; by working at once on this, the *original document* is always preserved, which is not the case when asses' skin is used, and which entails loss of time, and the chance of error incident to copying.

The requisite colours, &c., will be Indian ink, sepia, Prussian blue, gamboge, and lake for topographical purposes; when dispositions of troops are to appear, add cobalt, chrome yellow, and carmine, as being better suited, from their brilliancy, to catch the eye at once. The remaining items will be a small memorandum book, brushes, pencils, the metallic pens,‖ now so much used, knife, and India rubber. Many an

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* Now Major General Bainbrigge, C.B., to whom we are indebted for the materials of Sect. IV.

† The carbonate of iron is not magnetic; hence the needle is used in surveying the iron mines of South Wales, where the ore contains the metal in that form.

‡ Reflecting instruments have the great disadvantage, when used for fixing one's position from given points, of requiring three of them, whereas the compass requires only two points, and needs no construction beyond that of laying down the bearings to obtain their intersection.

§ Troughton and Simms, Fleet Street, London, make a good strong scale for sketching ground, with lines perpendicular to the lower edge that go quite across the scale, and which are very convenient when the normal lines, as shewn in Plate VIII., are used.

‖ Those of zinc, as but little liable to rust, are perhaps the best.

inconvenient day's work, or vexatious walk back, will be saved by calling over the *muster roll* of these things before starting

SECTIONS III AND IV

INTRODUCTORY REMARKS

In both of these Sections, the degree of detail in which the ground is to be shewn must depend on the purpose in hand; and in Section IV, on the time and opportunity afforded, to which in Section III no limit is placed

In Section III, without indulging in topographical niceties, a full account may be given of every feature of sufficient importance to be represented. In Section IV, nothing should be noticed that can be omitted; and the work in its rough way should speak as clearly and simply, as (with greater leisure for consideration) Section III should clearly and amply. Thus, in Section III, and in the case of a chalk district, in which, *from* the absorptive nature of the soil, the streams are usually few and small, it might be proper to notice a rivulet which then and there might be topographically important, or which, for Engineer purposes, might be wanted to form an *inundation*, but it would be absurd to notice it in *Section IV*, when insufficient to stop even infantry,—unless the ground were that of a camp, where the stream might be of consequence as a provision of water.

In Section III, more or less of pen work may be allowed, especially in representing the usual topographical hieroglyphics, as given in Plate VI, though the brush, with a little assistance, will work with *far* greater rapidity and equal force, with reference to hills, woods marshes, &c; and in general, for this Section, it may be said that the brush is in every way preferable to the pen or pencil when circumstances admit of its use, which is by no means always the case Every use, however, should be made of the conventional signs of colour, especially in shewing water in blue, forests by flat shades of green, &c No attempt should be made at expressing relief by light and shade in the field, though in skilful hands it may be advantageously used at home

What is wanted in Section IV, is something very simple and effective, that can be executed with sufficient accuracy and with the greatest despatch, and which may be immediately comprehensible by the General Officer for whom the sketch is made, under any circumstances of embarrassment and perplexity; and facility in doing this is *only* to be obtained by being familiarized with ground, as the result of previous study, practice, and attention to instructions, such perhaps as those given in Sections I II, and III

SECTION III

The sketcher is presumed to be equipped as specified in Section II, and to understand the use of his instruments, and other drawing apparatus; it would lead to much unsuitable detail to attempt memoranda on these subjects

Having carefully studied the ground in reference to the purpose in hand, and to the views given in Section I, proceed to detail and embody the ideas thus generally formed in the manner shewn in the following example,* in which it is assumed that no fixed points have been supplied (as pricked off from any general diagram), and have to be determined on the spot

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* The meridians have been omitted in Plates VII IX X for the sake of clearness but their use is shewn in Plate VIII

Example 1, Plate VII

Let A B C be the base, as obtained by pacing,—D, E, F, G, H, principal points fixed by intersections as they can be obtained, which in a regular survey would be obtained trigonometrically,—A 1, A 2, &c, &c., tangential bearings, which, by an early determination of the most important exterior points and lines, act as limits, preserving the work from distortion

Suppose the object to be principally the peninsula;

Now as the heights running from D to F do not offer a suitable base, from the interruption of the fort and the irregularities of the hills, the ground A B C should be selected for this purpose

Commencing at A, take bearings to the Martello tower (D), the flagstaff (E), and the south-west salient (*i*) of the fort. While on the spot, to avoid a useless recurrence to the same (and in military sketching you should never, if possible, *work twice* on the same ground), take the tangents A 1, A 2, A 3, A 4, which give limits in *one direction* to such parts of the contiguous coast, &c. as can be seen, and before leaving the station, sketch in as much of the ground as you can *fairly* judge, within a moderate distance all round; then pace on to B, noting such points as *a* (in the prolongation of the battery on the isthmus), or *b*, where you cross the road, &c., &c; and this sort of observation should be CONSTANTLY made, as a general rule, inasmuch as you are then certain that the *relative* positions of the different objects are nearly right, although, in some instances, the *absolute* ones may be occasionally erroneous, it binds the work, as it were, together.

At B, *fix* D, *i*, and E, by intersecting the bearings taken at A, take other principal *bearings to the point* C, *the tower* F, also the tangent B 1, which not only gives a *limit* to the rocks at *d*, but one to the coast at *e*. Proceed as before to C, remarking that at *f* the towers F and E are in a line with yourself*

At C, *fix* the tower F, by intersecting the bearing from B, and the point *e* by C 1, cutting B 1.

Having thus secured all the ground along which the base runs, on the north side of the gulf, return to the point *b* (where the base between A and B had crossed the road), and pace to, and lay down the works on the neck, sketching the ground to the right and left as you proceed

As D has been already fixed, you need not *pace* up to it after marking down the redoubt and long battery on the isthmus; but on arriving at the said point (D) take bearings to H, and the tower G; also the tangents† D 1, D 2, D 3. In order to lay down the south front of the fort, pace a line (B *g*) as near it as the marsh *h* will allow · the remainder of the work can be completed from station E

E After thus finishing the fort, *fix* the towers H and G by intersecting bearings (E H and E G), and then prove the accuracy of the situation of F by E F As the situation of B is more certain than that of C (since any accumulation of error from inaccurate pacing must of course be less on a short distance, A B, than on a longer one, A B C), E is a *senior* point to F (which was observed from C), therefore whatever position is given to this last from E, it must necessarily take precedence of that from C, and correction is to be made accordingly For a like reason, if on arrival at C, you

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* Work may often be checked and verified without a single measurement being taken, by thus availing oneself of such coincidences and arguments

† No opportunity should be missed of securing the general directions of the principal summits, crests and slopes of hills by these tangential bearings the continued intersection of which gives much assistance in not only fixing the position of hills but also their true forms

found that the bearing C K passed east, or west of K, then shorten or lengthen D C, until the aforesaid bearing intersects exactly

Next, place yourself outside the fort, as near as possible to F, judging the distance, and having laid it down, go towards F this distance (F F) pace, not from being uncertain of the place of F, but in order to ascertain that of the neck lying between it and the fort

Arrived at F, sketch the surrounding peninsula as nearly as may be judged, but not giving yourself much concern about it,—partly because the north side is already well defined by the tangents (B 1, E 1), and partly because you will see, that in going to the southern side of the main hill, and reaching the tower G, you will have abundant opportunities of laying down the south side of the peninsula (F) by such tangents as G 1, k 1, E 3

Then return to D, and pace towards G, so as to obtain proper points (i and k) on the line D G from these last (i, k) good intersections may be obtained (*i e* such as vary between 45° and 100° at the point where the bearings intersect) for fixing the point and houses (m), and from whence also tangents may be obtained to the shores of H n and o, by i 1, i 2, i 3,—k 1, k 2, k 3

In like manner proceed for any other points, and a very limited share of practice will give ample experience as to sketching the intermediate ground with sufficient fidelity for ordinary military purposes If, however, there should be any doubt as to the accuracy of any particular part, as at G 4, take a bearing in that direction *from* G, and pace on it to the point in question

Memoranda—The heights of the hills should, generally speaking, be given (usually in red) on the summits; and any conventional signs employed should be *invariably* explained in the margin,—such as those given in Section IV. to denote the different degrees of passability for the several descriptions of troops, &c

In plans of camps and battle fields, the top of the plan is always towards the enemy

Houses of masonry in red, of wood in Indian ink

Example 2

This was sketched in reference to a project of defence once made for the ground opposite Quebec As affording also a good field of action, it was accompanied by Plate IX, as an *Abstract of Facilities and Impediments* independent of the hill work in the original, the spaces now shaded were flat washes of green, to shew the woods From a sketch like Plate VIII a much more detailed plan can be made than would be necessary for any battle field, where much of what is now given would be improper, especially as from the fragmentary character of this drawing there was no scope (or occasion as it happened) for further completion of the form of ground as it now stands, it is only fit for a memorandum to enable the draughtsman to complete a finished and enlarged copy

The topographical character of this ground is as given in Plate I fig 3 (A and C), and at P 4 Q, fig 11, wherein a sort of hammer headed peninsular hill (A) comes to the St Lawrence with a flat valley bottom (B) between it and the next and like hill (C) These hills (A, C) are the last features of individual members of a series of offshoots from the water shed separating the waters of the St John from those of the St Lawrence

In sketching this ground, the road from Point Levi to Chaudiere gave an excellent main base, not only for the ground between A and the river, but also for fixing the opposite or Quebec bank The road D E F G, as a cross base, gave checks on many

sketch also it could be seen that the line to H passed over K The direction (J) was next taken, shewing the fall of ground and the direction of the road (D) There were no other points that could be fixed between D and the skirt of the wood (H)

R "I then galloped to the top of the hill, and placing myself in a line with the two farms (I and K), that line was assumed to be correct, and then observing the angles between K and Sta Martha, between K and C, and K and I, R was fixed

"At R I could see (over the trees) the village of Calvarosa Ariba, and also a chapel (called an Hermita) on this side of it, the directions to which were taken, also to the remarkable hill (S), and the abrupt slopes of the ground to the rear (U and V)

"A line was drawn to the fall, or gap, in the ground (T), taking great care that this, as well as those *to S, Calvarosa, and the chapel, were as correct as* possible in regard to the line from P, because the connection of the right of the position rested on this point, and the accuracy of the winding up of the sketch would depend on the correctness with which those angles were taken

T "Next to T, and as, on reaching it, it was clear that none of the points on the left of the position could be seen, except R, it became necessary that the distance from R to T should be judged as accurately as possible—which distance became a fresh base At T, thus fixed, all the right could be seen, and the Hermita could be intersected, as well as the ground to the rear (U, V, and Z) The direction (X) of the smaller hill was taken, and the line over its summit, *it was observed, passed to the abrupt right hand slope of the ground* (W), *to* the rear of the position A farm also, in a hollow of some wood to the front, was also noted

X "I then went to the smaller hill, intending to go to the top, but the rocks were so rugged I could not ride up, so, standing on a line between it and T, at X, that station was fixed by observing the direction to E and to the Hermita.

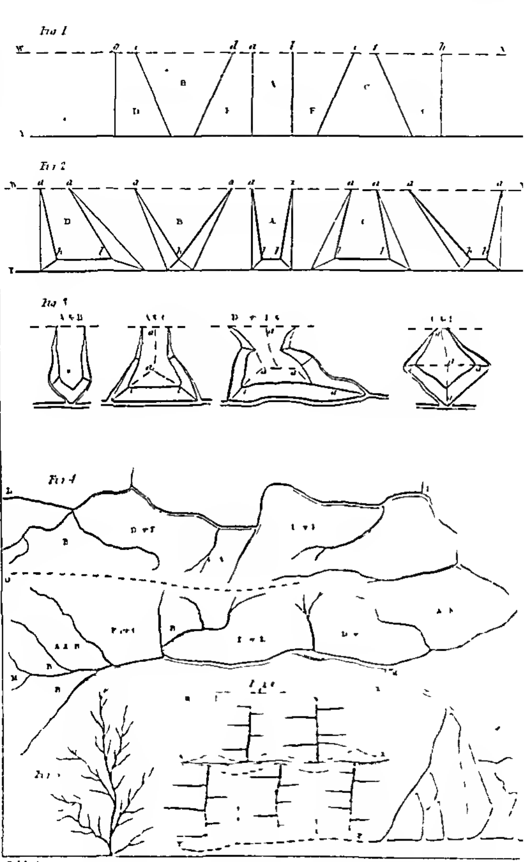
"The line to Calvarosa from R was next intersected, which fixed that place The direction to the houses (Z) was also laid down, and this place turned out to be the village of Arapiles, and the two remarkable hills were the celebrated hills of the same name

"The line W *being intersected* gave the boundary of the ground (Y) the farm in front, observed from T, could no longer be seen

"Passing then down by the right and along the hollow between the two great hills, I went to the Hermita, and this point having been before fixed, from thence the direction of the further fall of the great hill (S) and two slopes of the hill on the further side of the Calvarosa valley were secured, as well as the direction of the water course above and *below I then passed down the* valley, and wound up the sketch at O

"Going back from thence to C, I proceeded along the main road to D and E, putting in, on judgment, the village of Carvajosa, as well as the point F, where was a house, and where the great Salamanca road passed

"I returned to Cabrerizos, finding the Duke where I had left him and handed him the sketch having been absent about two hours and a half I made a verbal report to his Grace, pointing out the high hill (S) which we could plainly see from the spot where we then stood, observing that it was doubtful whether guns could be brought there, not having had time to ride thither



sketch also it could be seen that the line to it passed over K The direction (J) was next taken, shewing the fall of ground and the direction of the road (n) There were no other points that could be fixed between D and the skirt of the wood (R)

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"At R, I could see (over the trees) the village of Calvarosa Arriba, and also a chapel (called an Hermita) on this side of it, the directions to which were taken, also to the remarkable hill (S), and the abrupt slopes of the ground to the rear (U and V)

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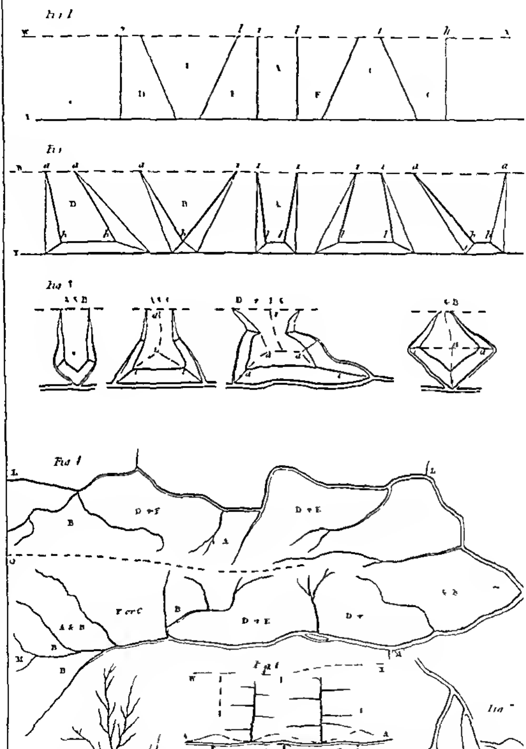
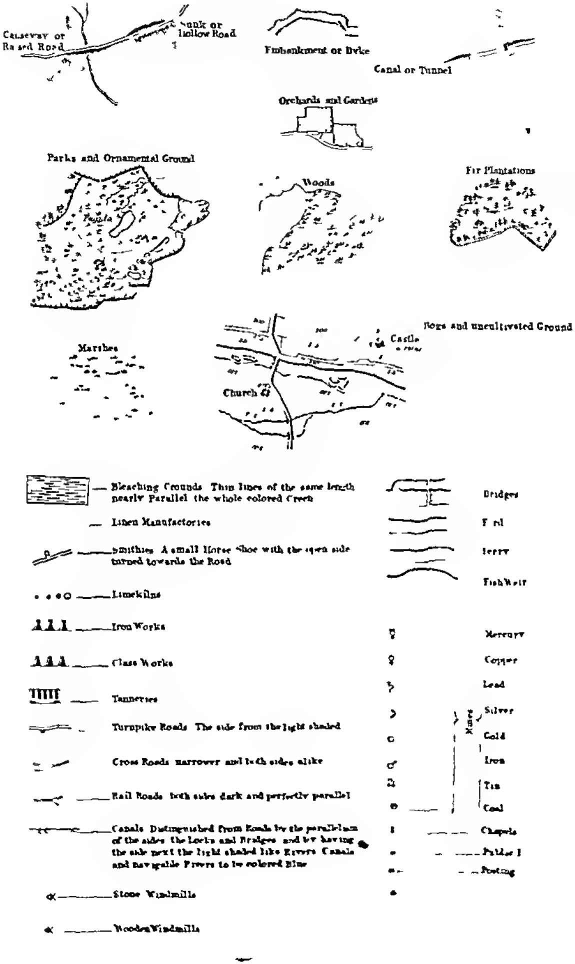


OUTLINE IMPRESSION

BY MEANS OF CONTOURS AND FEATURE LINES ONLY
FROM A SURVEY OF GROUND BY Mr DAWSON
1825

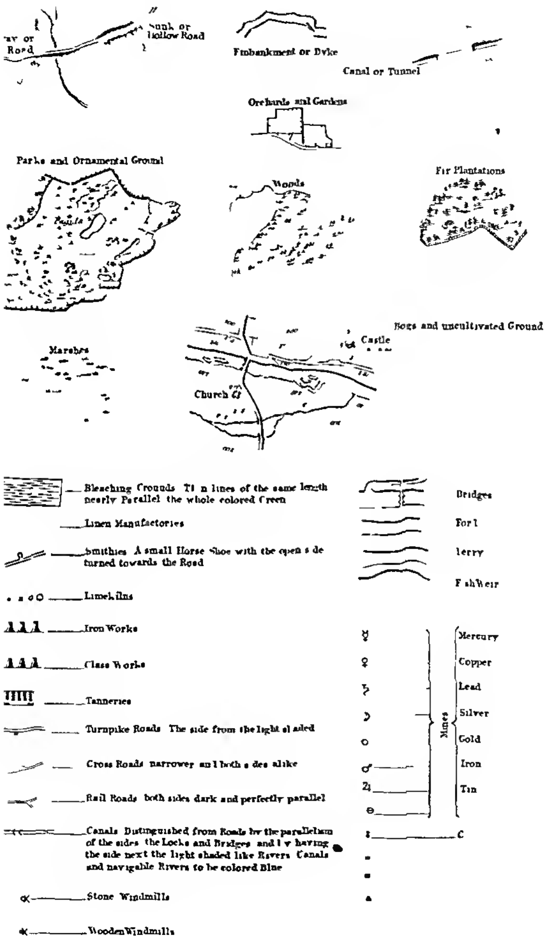
TOPOGRAPHICAL HIEROGLYPHICS,

ADOPTED BY THE ORDNANCE SURVEY

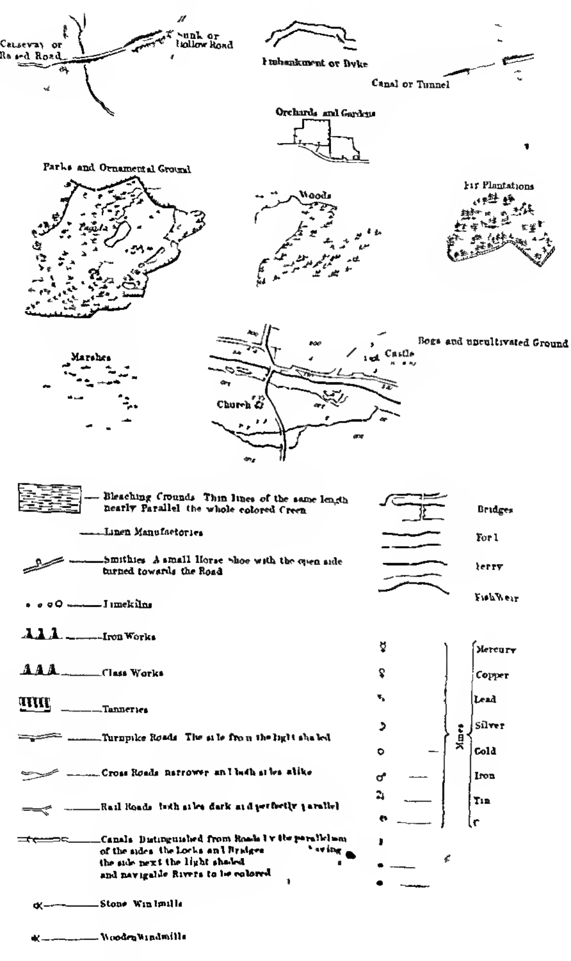


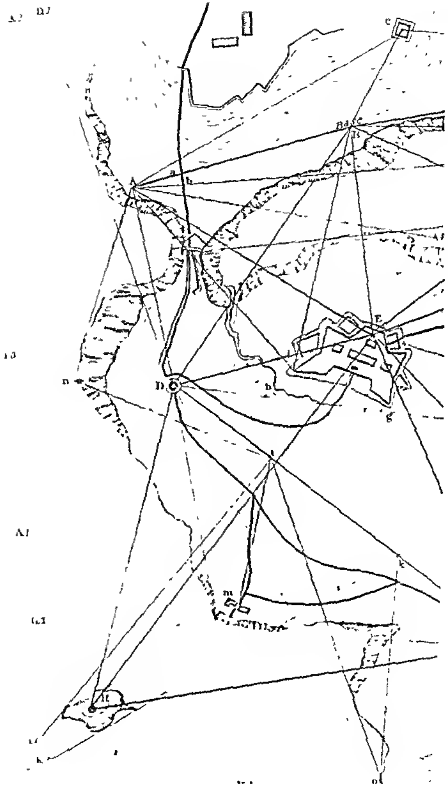
TOPOGRAPHICAL HIEROGLYPHICS.

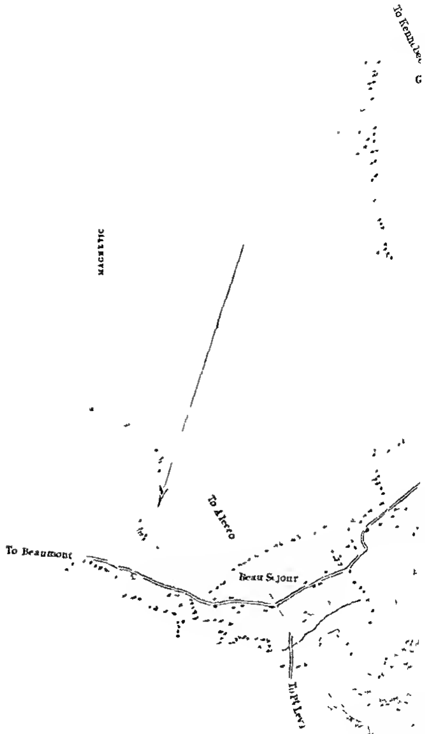
[illegible] SURVEY



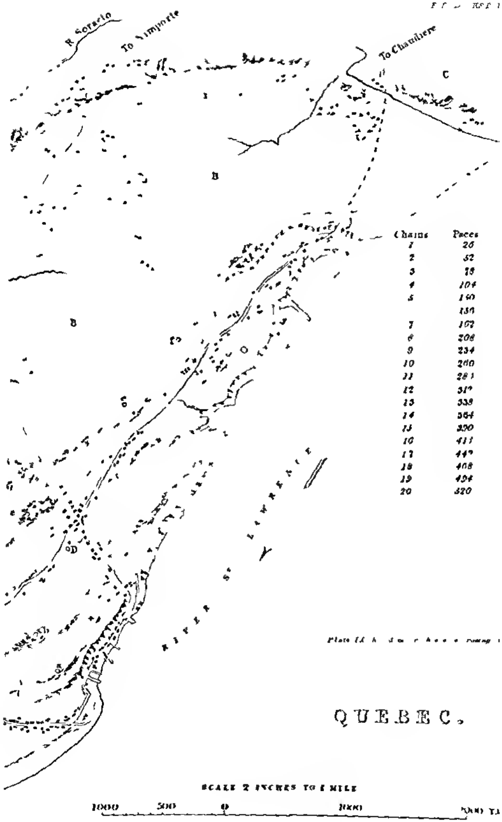
TOPOGRAPHICAL HIEROGLYPHICS,







N.B.—The original sketch was done in the horizontal [illegible] it was intended that the plate should have been a fac simile in that style, but by mistake the Engraver has omitted to do so. E.J.S.



Chains	Paces
1	26
2	52
3	78
4	104
5	[illegible]
	156
7	182
8	208
9	234
10	260
11	[illegible]
12	[illegible]
13	338
14	364
15	390
16	[illegible]
17	[illegible]
18	468
19	494
20	520

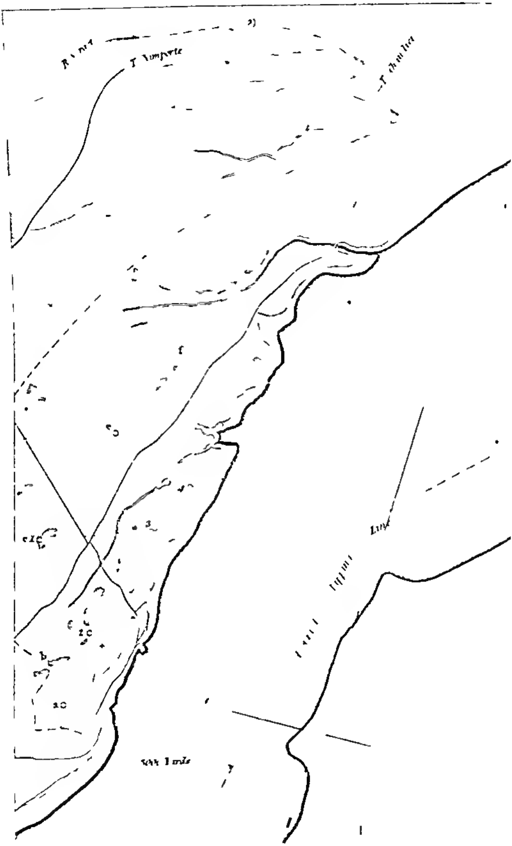
Abstract

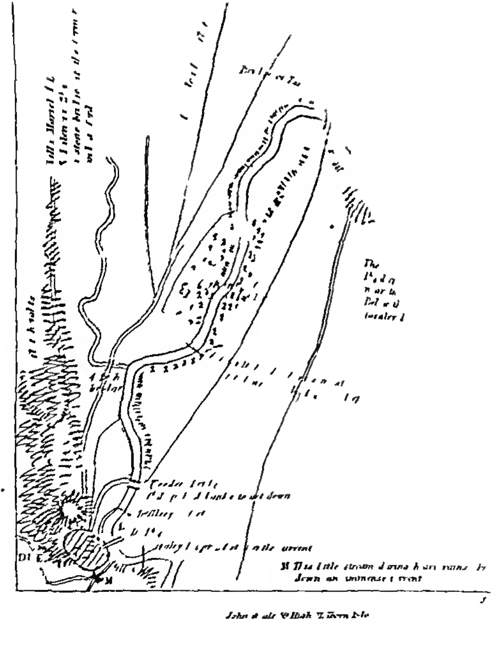
OF

POSTS, ROADS, WOODS, & WATER

[illegible]

[illegible]





The


Cabarasa Ariba
Village

FIRE, PRECAUTIONS AGAINST.

Our total failure in destroying the shipping at Antwerp in 1813–14 must be, in part, attributed to the measures taken by Carnot, who was then Governor. From such information as can be obtained, it would appear that they chiefly consisted in the establishment of well-organized fire-parties; and in securing the ships, by covering the decks with earth and dung, and supporting them by numerous props and stanchions.

What is given by Carnot, par. 47, 4th head of 'Defence of Fortresses,' may be combined with the following from Laisné. 2nd ed. p. 403.

" Lorsque la place est petite, ou si toutes les troupes ne peuvent être logées dans les quartiers où elles soient en sûreté contre les projectiles de l'assiégeant, on *blinde*, autant que possible, les casernes les plus rapprochées du front d'attaque.

" Il convient surtout d'affecter à l'usage d'hôpitaux, les souterrains les plus sains et les meilleurs bâtimens à l'épreuve soit voûtés, soit blindés au moment du besoin.

" Les fours, les puits et les citernes doivent également être garantis contre les bombes, par des blindages, s'ils ne se trouvent disposés dans les locaux voûtés à l'épreuve.

" Pour diminuer les effets de la chute et de l'explosion des projectiles, on peut, dépaver les cours et une partie des abords de tous les *établissements militaires*.

" L'un des plus grands dangers dans une place *assiégée étant* celui des incendies, on devra *organiser des compagnies* des *Pompiers-bourgeois*; former des réservoirs d'eau *multipliés*, avoir 20 grandes échelles de 10m de longueur, 40 échelles moyennes de 7m; 50 petites échelles de 4m, 40 crocs ferrés gros et longs emmanchés, 10 pompes à bras, 350 seaux de cuir.

" On placera sur les clochers les plus élevés des *guetteurs* qui au moyen de cloches et de porte voix, avertiront du feu et des endroit où il éclatera. Ces guetteurs pourront en même temps, pendant le jour, observer les mouvements de l'ennemi, et en prévenir le gouverneur, pour cela, ils descendront leur avis écrits," &c.

Napoleon's decree, 24th December, 1811, *article* 94, relative to the defence of places, was, " Le Service d'Incendie, en cas de siége, ou de bombardement, est reglée par le Gouverneur ou Commandant, de concert avec le Commandant de Génie et l'autorité civile."

It is to be observed that when a dockyard, in which there *are* several ships either in dock or on the stocks, *tolerably* near one another, is *once* thoroughly on fire, no hitherto arrangements in the way of ordinary fire-engines are of the *slightest* use. Dockyards should *be provided with reservoirs* with the requisite *steam power* arrangements for their supply, rather *from the sea** than from the common limited resources of water-companies. The head of water thus given, and led amongst the shipping, should be such as will pour *volumes*, not petty jets d'eau, as from common fire-engines, that do but aggravate the fierceness of the combustion by their insignificant streams, and embarrass all extensive arrangements by the confusion and interference of their numerous working parties with those employed in the removal of the neighbouring materials, &c.

The writer was on duty at the fire in Devonport Dockyard, in 1840. As long as the flames from the ships, their sheds, and the neighbouring piles of plank and timber,

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* Salt water freezes far less readily than fresh — hence an additional reason for availing oneself of this resource in countries near the sea, when the cold is severe and the pipes are frozen.

were at all inclined to advance, though driven on by only the very light wind of that morning, the engines could only retire, as it was *impossible* to face the heat It was only when the providential change of wind (the only thing that saved the yard) sent the fire back over the ground it had imperfectly cleared, that the fire engines could be at all satisfactorily employed One great cause of danger, in such cases, lies in the extraordinary height and distance to which pieces of burning wood are lifted and carried by the slightest zephyr, that when untouched would require a gale to move them along the ground when fully ignited, the volume of rarefied air around them evidently gives them the buoyancy of a fire-balloon.

In extinguishing fires in towns, an Engineer will act wisely to avoid having anything to do with them, unless on a distinct understanding with the municipal authorities that his directions are to be implicitly followed, and that the police assist in keeping the ground clear When there is a military party co operating, the task is far more likely to be satisfactory The first thing to be done is to plant lines of sentries to keep off the mob, allowing no one to pass but such as are called by the police lines of men should also be formed to the nearest pumps and wells, to pass on buckets, either to feed the engines, or be thrown on the flames Orders being given to this effect, the Officer will, in general, save time by reconnoitring the building outside and inside, quickly, before he posts the engines, or takes other measures Possibly some arrangements will have been made by others before he arrives, and in this case, where disturbing such may be unadvisable, even to afford a better application, it is of consequence to feel, "It is too late to do what I wish,—I will do the best with what remains to be done," and then act with decision and energy. In making examination inside, he may often creep on hands and knees, along passages and into rooms, breathing freely, where he could not stand upright half a minute without suffocation

There are no tools, on such occasions, like the crow bar and felling axe, the former for knocking holes through walls, to make short lines for passing the hoses, and both, *for destroying floors, partitions, &c*, especially such as are in any way connected with or composed of lath and plaster, where fire lurks in a way not easily conceived by those who have not seen it *

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† "The intensity and consequent danger from fire is (*cæteris paribus*) as the cubic contents of the building in which the fire takes place

"In warehouses or stores, where large quantities of combustible goods are kept, floors of brick arches, supported by cast iron pillars and bearers, are no protection as the *heat is sufficient to fuse the cast iron, or to weaken it, so as to render it unable to* bear the weight and strain of the arches The heat also expands the iron to such an extent as to unsettle the brick-work the wrought ties also become useless from expansion and losing their rigidity

"These remarks do not apply to dwelling houses, as the use of cast iron bearers reduces the quantity of timber so much, that if there is nothing kept in the house, with the exception of the usual quantity of furniture, it is not likely that the heat will be great enough seriously to injure the cast iron, if sufficiently strong originally, which is not always the case

"Sheet iron nailed over timber is no protection against continued heat, but only against flame for a short time

"Several buildings have been set fire to by the use of iron hearths

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* For notices on the use of powder in fires see 'Demolition'—buildings

† From a letter with which the Committee were favoured by Mr Braidwood (63, Watling Street), Superintendent of the London Fire Engine Establishment

"Wherever a wall can possibly be carried through the roof, it is the best protection against fire, even if there should be openings in the floors below When a fire takes place, the heated air and smoke rises immediately, and fills the roof and upper floors, causing the materials to give off gas, which takes fire as soon as the fresh air is admitted below to carry up the flame

"In extinguishing fires, the first point is, to keep the building where the fire is as much shut up as possible, till the engines, or other means to extinguish it, are ready for use, and then to get inside the building on fire if this cannot be done, it is generally expected that the building will be destroyed, and in that case greater attention ought to be given to the adjoining premises When an engine is sent to a fire here, the usual number of firemen is four besides the driver these men are employed first in attaching the hose and suction, and then in directing the jet and the working of the engine the mere manual labour is performed by the mob, who are paid at the rate of 1*s* for the first, and 6*d* for each succeeding hour"

EXTRACTS FROM THE "GENERAL REGULATIONS FOR THE LONDON FIRE ENGINE ESTABLISHMENT," CONSISTING OF EIGHTEEN OF THE PRINCIPAL INSURANCE AND OTHER PUBLIC COMPANIES

Organization

London is divided into five districts, three on the north of the Thames, two on the south, in each of which is stationed a sufficient number of engines under the charge of a Foreman, with Engineer and Firemen under him The Superintendent has the command of the whole force

The men are clothed uniformly, are distinguished by numbers, and are regularly exercised in the use of their engines their whole time and service belongs to the Establishment

General Memoranda

"To execute their duties as *steadily* and *quietly* as possible, to be careful not to annoy the inhabitants of houses they may be called upon to enter to treat all persons with civility, to take care to preserve *presence of mind and good temper*, and not to allow themselves to be distracted from their duty by the advice or directions of any persons but their own officers"

Conditions of Service

"The age of admission of men to be, Engineers not exceeding 30, and Firemen not exceeding 40 years Not exceeding 25, nor under 18, for men who have not previously been Firemen Pay varies for Firemen from 21*s* to 24*s* 6*d* per week, the Engineer and Foreman 28*s* per week. Foreman of Districts 1*s* per week extra for every engine under his charge Uniform is found by the Establishment"

Outline of General Duty

"One third of the men to be on duty night and day at the different engine houses —the whole to be liable to be called up for attendance at fires, or for any other duty" On a fire breaking out, the whole of the men of that district, ⅔rds of the collateral, and ⅓rd of the flank district, are to be in attendance, also 1 engine from collateral district, and 1 from one flank In case of doubt as to boundary, both adjoining districts send all, and the remaining three send ⅓rd. In case of emergency the Superintendent will call in such additional force as he may require. The engines will be conveyed to fires at not less than 7 miles per hour, and the men who do not accompany the engine at not less than 5 miles per hour

were at all inclined to advance, though driven on by only the very light wind of that morning, the engines could only retire, as it was *impossible* to face the heat. It was only when the *providential change of wind (the only thing that saved the yard)* sent the fire back over the ground it had imperfectly cleared that the fire engines could be at all satisfactorily employed. One great cause of danger, in such cases, lies in the extraordinary height and distance to which pieces of burning wood are lifted and carried by the slightest zephyr, that when untouched would require a gale to move them along the ground: when fully ignited, the volume of rarefied air around them evidently gives them the buoyancy of a fire balloon.

In extinguishing fires in towns, an Engineer will act wisely to avoid having anything to do with them, unless on a distinct understanding with the municipal authorities that his directions are to be implicitly followed and that the police assist in keeping the ground clear. When there is a military party co-operating, the task is far more likely to be satisfactory. The first thing to be done is to plant lines of sentries to keep off the mob, allowing no one to pass but such as are called by the police: lines of men should also be formed to the nearest pumps and wells, to pass on buckets, either to feed the engines, or be thrown on the flames. Orders being given to this effect, the Officer will, in general, save time by reconnoitring the building outside and inside, quickly, before he posts the engines, or takes other measures. Possibly some arrangements will have been made by others before he arrives: and in this case where disturbing such may be unadvisable, even to afford a better application, it is of consequence to feel, "It is too late to do what I wish—I will do the best with what remains to be done;" and then act with decision and energy. In making examination inside, he may often creep on hands and knees, along passages and into rooms, breathing freely, where he could not stand upright half a minute without suffocation.

There are no tools on such occasions, like the crow bar and felling axe, the former for knocking holes through walls, to make short lines for passing the hoses, and both, for destroying floors, partitions, &c., especially such as are in any way connected with or composed of lath and plaster, where fire lurks in a way not easily conceived by those who have not seen it.*

† "The intensity and consequent danger from fire is (*cæteris paribus*) as the cubic contents of the building in which the fire takes place.

"In warehouses or stores, where large quantities of combustible goods are kept, floors of brick arches, supported by cast iron pillars and bearers, are no protection, as the heat is sufficient to fuse the cast iron, or to weaken it, so as to render it unable to bear the weight and strain of the arches. The heat also expands the iron to such an extent as to unsettle the brick work: the wrought ties also become useless from expansion and losing their rigidity.

"These remarks do not apply to dwelling houses, as the use of cast iron bearers reduces the quantity of timber so much, that if there is nothing kept in the house, with the exception of the usual quantity of furniture, it is not likely that the heat will be great enough seriously to injure the cast iron, if sufficiently strong originally, which is not always the case.

"Sheet iron nailed over timber is no protection against continued heat, but only against flame for a short time.

"Several buildings have been set fire to by the use of iron hearths.

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* For notices on the use of powder in fires, see "Demolition—Buildings."

† From a letter with which the Committee were favoured by Mr. Braidwood (63, Watling Street), Superintendent of the London Fire Engine Establishment.

"Wherever a wall can possibly be carried through the roof, it is the best protection against fire, even if there should be openings in the floors below When a fire takes place, the heated air and smoke rises immediately, and fills the roof and upper floors, causing the materials to give off gas, which takes fire as soon as the fresh air is admitted below to carry up the flame

"In extinguishing fires, the first point is, to keep the building where the fire is as much shut up as possible, till the engines, or other means to extinguish it, are ready for use, and then to get inside the building on fire: If this cannot be done, it is generally expected that the building will be destroyed, and in that case greater attention ought to be given to the adjoining premises When an engine is sent to a fire here, the usual number of firemen is four besides the driver these men are employed first in attaching the hose and suction, and then in directing the jet and the working of the engine the mere manual labour is performed by the mob, who are paid at the rate of 1*s* for the first, and 6*d* for each succeeding hour"

EXTRACTS FROM THE "GENERAL REGULATIONS FOR THE LONDON FIRE ENGINE ESTABLISHMENT," CONSISTING OF EIGHTEEN OF THE PRINCIPAL INSURANCE AND OTHER PUBLIC COMPANIES

Organization

London is divided into five districts, three on the north of the Thames, two on the south, in each of which is stationed a sufficient number of engines, under the charge of a Foreman, with Engineer and Firemen under him The Superintendent has the command of the whole force.

The men are clothed uniformly, are distinguished by numbers, and are regularly exercised in the use of their engines their whole time and service belongs to the Establishment

General Memoranda

"To execute their duties as *steadily* and *quietly* as possible, to be careful not to annoy the inhabitants of houses they may be called upon to enter, to treat all persons with civility, to take care to preserve *presence of mind and good temper*, and not to allow themselves to be distracted from their duty by the advice or directions of any persons but their own officers"

Conditions of Service

"The age of admission of men to be, Engineers not exceeding 50, and Firemen not exceeding 40 years Not exceeding 25, nor under 18, for men who have not previously been Firemen Pay varies for Firemen from 21*s* to 24*s* 6*d* per week; the Engineer and Foreman 28*s* per week Foreman of Districts 1*s* per week extra for every engine under his charge Uniform is found by the Establishment"

Outline of General Duty

"One third of the men to be on duty night and day at the different engine houses —the whole to be liable to be called up for attendance at fires, or for any other duty." On a fire breaking out, the whole of the men of that district, ⅔rds of the collateral, and ⅓rd of the flank district, are to be in attendance, also 1 engine from collateral district, and 1 from one flank In case of doubt as to boundary, both adjoining districts send all, and the remaining three send ⅓rd. In case of emergency the Superintendent will call in such additional force as he may require The engines will be conveyed to fires at not less than 7 miles per hour, and the men who do not accompany the engine at not less than 5 miles per hour

used at, say, 32 degrees Fahrenheit, much lower than the gas, yet it is found that a very small part assumes the form of vapour on coming in contact with flame, and spreads through it, the greater quantity falls down by its superior weight and is wasted"

The Prices of Machines and Charges

	Size of Machine Height Inches	Diameter Inches	Price including One Charge £ s d	Price of each Spare Charge £ s d
No 1	16	8	2 2 0	0 5 0
2	18	9	3 0 0	0 7 6
3	20	10	4 0 0	0 10 0
4	22	11	5 0 0	0 12 0
5	24	12	6 0 0	0 14 0

The machines can be made to order of any size, at a proportionate price

FIRE CART.

Notwithstanding all that system can effect, much precious time, *in first moments*, is consumed before the establishment of fire-engines in our dockyards and arsenals can be brought into play in case of fire The following practice obtains in the Devonport Dockyard, and whether the fire has broken out in the yard or not, an invaluable assistance is promptly on the spot, before most or any of the Fire Office engines, or those of the neighbouring barracks, are well in motion

A large strong cart is fitted up to carry either the engine,—or else the party, with the engine dragging behind * The best kind of cart is that which (with wheels of the usual size) is slung very low on a crooked axle, as in the description called 'ducks' at Woolwich, and 'floats' in Dublin Two horses are always at hand, with a strong but very simple harness, besides saddle, whip, and spurs, for the driver, who goes as postilion

Attached to the engine are as many buckets as can be conveniently hung, the hoses are coiled away on the top of the well, the branch pipe and suction hoses lashed to the side of the body, a double screw box (one end fitting the town pipes and the other those of the dockyard), wrenches, hammer, spare leather washers, &c, &c, are in a small box, two or three coils of 2½ inch rope of 50 yards each, (for fire hooks, and letting down persons from windows) and a coil of 50 yards of 1¼ inch line for passing hoses and stores both sorts of rope should be well worked till rendered soft and pliable Fixed to the sides and ends are 2 felling axes, 2 sledge hammers 2 crow-bars 2 shovels and 2 pickaxes, as well as the drag ropes, and extra purchases The cart is fitted with a cross bar in front by which the party hold on when they are carried to the ends of this bar, sockets for a pair of carriage lanthorns are fixed At convenient points on the sides and ends (inside and out) are hung the buckets, 2 short ladders, (capable of being joined like escalading ladders?) and the tools above mentioned the points and edges of which last must be guarded when they are inside the cart, to prevent injuries to the party in the dark The men as a matter of course, are provided with leather helmets gauntlets and screens for their faces, like those worn by blacksmiths As thus arranged, an Officer† and party have started well *within* 10 minutes after the alarm was given

* For short distances only when thus dragged behind

† Lieutenant Williams R N by whom the above was contrived and executed

It may be advisable to add to the above a copper-covered chest fitted with powder-bags, portfires, &c., principally for the purpose of cutting off a mass of houses irrecoverably on fire, by the rapid destruction of a line of intermediate buildings.

R. J. N.

FORAGE, BULK AND WEIGHT OF.—From measurements taken expressly for this article.

Hay in flat and tolerably square bundles, as usually delivered	$4\frac{1}{4}$ lbs. per cub. ft. Trusses supposed to weigh 56 lbs., but varying from 52 to 58 lbs.
Straw in flat and tolerably square bundles, though not so compact	$3\frac{1}{12}$ lbs. per cub. ft. Trusses supposed to weigh 38 lbs., but varying from 30 to 40 lbs.
Oats, new	3·64 cub. ft. per cwt.
Barley, do.	2·39 „ „
Wheat, kiln-dried*	2·36 „ „

Of course considerable allowance would be made, in providing space for forage, on the above quantities.

The ration of forage for Artillery and Cavalry, at home, is

Oats	10 lbs.
Hay	12 „
Straw .	8 „

R. J. N.

FORDS †

In examining and reporting upon a ford, the main points to be considered are the firmness and regularity of the bottom, its length, width, and direction, the depth (and its increase by tides or floods), the rapidity of the current, the facilities of access, security from attack, and the means of rendering it impassable a ford should always be tried personally before making a report on its capabilities.

The *depth* of fords for cavalry should not be more than 4 feet 4 inches, and for infantry 3 feet 3 inches, but if the stream is not very rapid, and the direction of the crossing is down-stream, the latter may pass by holding on to the horses, even if the depth is 4 feet Should the stream be very rapid, however, depths much less than these could not be considered fordable, particularly if the bottom is uneven. Carriages with wheels 5 feet in diameter may cross a ford 4 feet deep, but if it is necessary to keep their contents dry, the depth should not be more than 2, or at most 2½ feet. Fords are generally to be found above or below a bend,‡ and often lie in lines diagonally across the river small gravel forms the best bottom; and rock, on the contrary, the most dangerous, unless perfectly regular and not slippery. They *may be sounded by means of a boat having a pole attached. But cavalry or good*

* Inserted here as matter of convenience raw wheat is somewhat lighter

† By Captain Bainbrigge, R.E

‡ See Professional Papers, vol. v p. 9 para. 6, 7, 8